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## GEOLOGY IN SCHOOLS AND UNIVERSITIES

THE practical value of geology to the community has been realized by government departments and by industry to an increasing extent during and since the War. As a consequence, until quite recently the demand in Britain for geologists has exceeded the supply. The publication by the Technical and Scientific Register branch of the Ministry of Labour of a pamphlet* that discusses the future demand for geologists is therefore timely. The booklet forms one of a series, published or in preparation, dealing with a number of the scientific and technical professions. Lord Hankey, chairman of the Technical Personnel Committee responsible for these publications, expresses, in a general foreword, the hope that the reports will be of use to universities, schools, professional bodies and other authorities concerned with the recruitment, education and training of future members of these professions.

The report on geology has been compiled by a sub-committee which included the directors of the Geological Surveys of Great Britain and the Colonies, after studying the evidence presented by representatives of the schools, universities, professional bodies and selected industries.

The main conclusions and recommendations are that, in general, the demand for geologists as such, either at home or abroad, is likely to be entirely confined to really good men of first- or second-class honours standard; and most geologists who qualify will have to find posts overseas, for which a further essential qualification is the passing of a rigorous medical examination. The demands for geologists in Britain—for the Geological Survey and the staffs of British universities—will be appreciably smaller than for the overseas posts. Opportunities for less highly qualified geologists will probably be few, apart from such as are absorbed by the Geological Survey in Great Britain in the grade of assistant experimental officer.

In the matter of training, the Committee states that the unanimous view of those who gave evidence was that a complete course in pure geology is essential for the training of a professional geologist, and that specialization should follow such a course, generally through postgraduate study. The importance of a knowledge of geophysics was stressed by a number of the representatives of 'user' interests.

It was pointed out that the supply of geologists before the War (presumably of those intending to make geology a career) was of the order of only twenty per annum, but that the number will be much greater in the next two or three years, the estimates being 127 for 1948, 112 for 1949 and 140 for 1950. Of these, it was suggested, perhaps some 60 per cent will obtain a good honours degree. On this basis, and from the evidence submitted to the Committee, the estimated supply up to 1952 is given as 76 in 1948, 67 in 1949 and 84 in the three remaining

* Ministry of Labour and National Service: Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications in Geology. 1 p. 16. (London: His Majesty's Stationery Office, 1949.) 4*d*. net.

years of the period. The estimated demand for the Geological Survey of Great Britain is 10 annually, for Colonial Geological Surveys 27, 36, 33, 21 and 12, for oil geology 20 annually, for mining geology 30 in 1948 and 7 annually afterwards, and for the universities 6 annually. Thus the estimated demand would overtake the probable supply by 1950, and would exceed it substantially (84 available to 55 required) in 1952. It is also noted: (1) a part of the demand for oil geologists will be met from the Dominions; (2) in addition, there will be a very small demand amounting in all to 5–10 annually from technical colleges and schools, museums, other government departments, etc., and industry (other than oil and mining). That the figures for 1948 are only 'estimated' is explained by the fact that the report is dated August 1948, and it is surprising that publication should have been delayed until December 1949.

The specific terms of reference of the Geologists' Sub-Committee are not stated; but the report, brief as it is, has succeeded in achieving its main object in providing useful guidance, so far as the immediate future is concerned, to those concerned with the recruitment and training of professional geologists for the specific fields mentioned above.

Looking to a slightly more distant future, however, one cannot help wondering what the ultimate effect of this report may be. Within a day or two of publication, reports in this series were being purchased by students themselves, and it seems not unreasonable to suppose that to a young student who reads that few but good honours graduates could expect to obtain employment as professional geologists, and that from 1950 onwards the supply is expected to exceed the demand, the report would quickly repress any aspirations he may have had for geology as a career. In these strenuous days, it is the career value of a subject that most students must of necessity consider first; and it is difficult to suggest, on the basis of this report, that any educational adviser could do other than point out that, very soon, the demand in Great Britain for geologists is likely to fall considerably below the supply.

Geology is taught as a separate subject in very few schools in Britain; and if a student becomes aware of it as a possible degree subject before proceeding to a university, it may only be by chance, perhaps as a result of learning about it from a teacher of geography who has a personal interest in the subject. Therefore, a student may arrive in a university with a good basic knowledge of chemistry, physics, mathematics, botany and, not infrequently, zoology—but very rarely geology. One might therefore have hoped that the newly published booklet would have indicated to teachers and senior scholars what advantages geology had to offer when studied as a subject for a general degree course. It may, for example, be taken with advantage by those who propose to follow advanced courses in archæology, forestry or town planning; and how often, one may ask, does a student whose special bent is mathematics or physics have it pointed out to him that such subjects might be usefully combined with geology, with the view of a career in geophysics? As already mentioned, the importance of a knowledge of geophysics is stressed by the report.

It therefore seems that an opportunity has been missed, in omitting from this report any reference to the value of geology as a subsidiary subject in a number of careers. Moreover, the openings in geology for women are not indicated. Women are, for example, eligible for appointments in the Civil Service as assistant experimental officers, and a number with geological qualifications have already been appointed to such posts.

It is to be feared that one of the results of this report may be to warn off all but the most enthusiastic from geology as a career, and even reduce the supply in the not very distant future to a level below the demand. It would be unfortunate if its effect were to push geology back again into the position of being the Cinderella of the sciences in the educational system of Britain, a position from which it has only in recent years shown signs of emerging. Perhaps in future editions of this pamphlet additions might be made indicating the possibilities for those who, although they may not make geology their principal life-work, nevertheless would find a knowledge of it of value to them both professionally and culturally.

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## MAN STUDIES HIMSELF

### Personality

In Nature, Society and Culture. Edited by Clyde Kluckhohn and Henry A. Murray. Pp. xxi+561+x. (London: Jonathan Cape, Ltd., 1949.) 30*s*. net.

THIS is a kind of anthology, except that perhaps it would be an exaggeration to say that the items of the collection are chosen for their beauty. There are so many of them—thirty-eight in a book of 561 pages—that it is next to impossible to give a brief description of their contents, and almost as difficult to say what, if anything, they all amount to. It is true enough to say that they are all concerned with some characteristic, general or specific, of the relation between man as an individual and men as they are organised into a form of society, and that, with some exceptions, this is not regarded simply as an opposing relationship, but as one in which each side draws from the other many things which give it ultimately an appearance of permanent structure.

The editors, who are already well known for earlier and, in many quarters, highly approved studies of human personality, preface the whole by a rather abstract and difficult essay. This eventually arrives at the statement: "Personality is the continuity of functional forces and forms manifested through sequences of organised regnant processes in the brain from birth to death". It seems as if this ought to mean that personality is what it does. But if we are left with the impression, as we may well be if we succeed in reading and accepting the whole of this large volume, that it does anything and everything according to occasion and opportunity, then such an assertion does not perhaps help very much. Indeed, however, the case is not so bad, or so simple as all this. For, no matter what may be the diversity of occasion and opportunity, personality can be regarded as operating according to a certain limited number of principles.

The key idea, which seems to have almost an obsessive force in much current American writing about men in society, is the 'reduction of tensions'. 'Tension' may seem as if it is a perfectly objective term. But, in point of fact, in this context it always tends to appear as some form of felt discomfort, or as disappointment actually experienced or psychologically anticipated. So the basic effort is always one of avoidance; but avoidance may take peculiar forms, so that it sometimes appears not as a mechanism of escape but as one of achievement. Either way, the devices that can be adopted are limited. A man may, for example, go to sleep; personality allows "for the periodic regeneration of energies by sleep". But, whether fortunately or unfortunately it is not stated, nobody can sleep all the time except in fairy tales. So he can elect to reduce himself to a sort of semi-comatose permanent state by "restricting the number and lowering the level of goals to be attained". If he does, he becomes presumably one of those whom Confucius called "the good, comfortable people of the villages". Or he can admit his discomforts but postpone their resolution to some distant and unknown date and clime, and then he may become a tolerably happy idealist, with or without religion, accepting the knocks of terrestrial fortune as the price of future bliss; or he may disapprove everybody else in a persistent course of approving himself. Again, he may "design serial programmes for the attainment of distant goals", and "follow schedules which result in a harmonious way of life". Then, he is the person who comes to let the generality of the rule swallow up the bitterness of the particular example. Finally, he may "reduce conflicts between personal dispositions and social sanctions . . . by a series of compromise formations, the trend of which is towards an emotional identification with both the conserving and the creating forces of society".

Whatever may be thought of all this from other points of view, it certainly presents an excellent scheme for a book. In all its varieties human personality is seen as a process of formation which can be followed through a set of nice, tidy categories. It starts, develops, becomes more or less stereotyped and then, perhaps, declines. These are successive stages, and we can take each stage in turn, and try to discover what are the main conditions operating in a sufficient number and diversity of concrete settings. The descriptive results may take any of the forms set out in the scheme; but the rules of operation of the conditions may be found constant for all the forms. This is what the book endeavours to show, by presenting single selected chapters from the specific researches of the thirty-eight writers represented, with brief introductory remarks by the editors.

The crux of the whole matter is really the starting-point. It has to be supposed that both individual and society possess a constitutional structure, for without this there seems to be no good reason why either should develop that relatively permanent form called personality. The individual constitution is said to be a blend of genetical, physical and physiological, psychosomatic and psychological elements. None of these, especially the psychosomatic, is very clearly defined. The psychological elements are said to be extremely persistent modes of perceiving, recognizing, recalling and, in general, of carrying out the "higher mental functions"; but no specific evidence is given for them in the constitutional section, though this might be attempted.

The elements of social constitution are not stated. Perhaps it is left to be assumed that they are the same elements but blended in a much more complex fashion, because the unit is an organised population and not simply a number of persons each with his own body. But this does not seem to be correct, for in almost all the succeeding discussions the social contribution to individual personality formation appears to be made through items, or clusters of items, of a specifically social possession called "culture"; and "culture" is not—and perhaps cannot be—presented as a blend of the individual constitutional elements. There is a troublesome gap here.

Having achieved this basic expository scheme, of an individual with a constitution and a society with culture, the book goes on to illustrate the influence of culture upon constitution in particular instances of the former. There are some influences which a society exerts upon all its members; these are called "group membership determinants". There are others which it exerts only upon those of its members who have particular positions and functions; these are called "role determinants". There are still others which it exerts upon all or some through particular situations; these are called "situational determinants". Finally, there are cases in which all or some of these influences are combined; these are called "interrelated determinants".

Much of this extracted material is intensely interesting. But it is so diversified and covers so many specialized communities that only a person of encyclopædic range could form a fair opinion of the reliability of the evidence given and the justification of the conclusions drawn. Moreover, all that appears to be achieved is a series of more or less apt illustrations of the original thesis.

Many readers are likely to agree that there is much in the book which shows that there are plenty of aspects of human social behaviour which can be scientifically studied, given a concrete setting. More still are likely to agree that the general theory which the editors advance is not itself demonstrated in a scientific manner, and that by this type of approach it never could be.

F. C. BARTLETT

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# COLORIMETRY IN CHEMICAL ANALYSIS

## Colorimetric Methods of Analysis

Including some Turbidimetric and Nephelometric Methods. By Dr. Foster Dee Snell and Dr. Cornelia T. Snell. Third edition. Vol. 1: Theory—Instruments—pH. Pp. xii+239. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 25s. net.

SINCE the publication of the second edition of this work ten years ago, colorimetric analysis has become much more widely used. During this interval many suitable instruments have become available, and knowledge of the importance of trace elements in human food and fodder for cattle, contaminants in metals, etc., has greatly increased. Original contributions to the literature on the subject of colorimetry have been on a very large scale, covering such a wide range of subjects as biology, nutrition, drugs, metallurgy and instrument design. The present volume deals with the theory of colorimetric methods,

a description of the instruments used and methods of determining hydrogen-ion concentration.

The number of references to the scientific literature is truly remarkable and may in some cases prove an embarrassment to the reader, as the authors of the volume cannot deal critically with, and summarize adequately, such a mass of information. The volume is profusely illustrated, contains many useful tabulated data, and is well printed and reasonably free from errors. Page 63 in the review copy forms an exception, since the letter *t* is missing in consecutive words, and the number of different gradations of colour which the human eye can detect is given as about 10,000, which appears to be a misprint for Judd and Kelly's estimate of 10,000,000. The authors have described and illustrated a comprehensive selection of instruments used in colorimetry, which should enable the reader to choose one suitable for any purpose. Information on the spectral response of commercial barrier-layer and photo-emissive cells used in many of these instruments would have been useful, as well as some account of cell fatigue. Most readers would prefer working diagrams rather than so many pictorial illustrations which are readily available in catalogues. While many of the schematic diagrams are excellent, that of the Hardy colorimeter omits some essential details, and diagrams of some of the well-known spectrophotometers are omitted altogether.

It is to be regretted that the authors consider that photo-electric tri-stimulus colorimetry is outside the field of colorimetric analysis. No text-book written mainly for chemists has yet dealt with this subject, in spite of its importance in the measurement of the colour of paints, pigments, inks, signal glasses, etc. Two colorimeters mentioned in the volume, namely, the Hardy and the Lovibond–Schofield, are capable of being used for the measurement of colour in terms of the system of the Commission Internationale de l'Eclairage, the internationally accepted method of colour expression. The chapter devoted to the characteristics of colour filters gives information difficult to obtain elsewhere, although more diagrams correlating transmittancy with wave-length, or tables giving percentage transmission at various wave-lengths, would have been useful. The use of fluorimetry in analysis is limited to a description of the instruments employed. The subject has assumed increasing importance in recent years in its application to the estimation of aneurine and riboflavine, and many readers would have appreciated more information on the essential theory and the difficulties in obtaining reliable measurements due to quenching, etc.

Much useful information is given in the section devoted to accuracy, which is well worth careful study by even practised workers in colorimetry. Some modification is desirable in the statement "It is usually easier to distinguish between two colours than between colorless and colored". Sandell, in his book "Colorimetric Determination of Traces of Metals", is in difficulty on this point, whereas the advocates of the so-called achromatic indicators are opposed to Snells's statement. The use of indicators for the measurement of hydrogen-ion concentration is dealt with very fully, and with a wealth of practical details to be observed when dealing with food products and biological specimens. Workers in these fields who are not physical chemists would be well advised to study this section carefully before embarking on measurements of the *p*H of their specimens. Readers unfamiliar with the terms used would have appreciated definitions at an early stage; for example, the significance of the isobestic point in the transmission curves of indicators is not explained, and the definition of the isohydric points of indicator solutions is considerably delayed. Neither term can be found in the index.

This revised and enlarged edition with its numerous references is a valuable addition to the literature on colorimetry and will be welcomed by all workers using colorimetric methods of analysis.

JOHN KING

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# GREEK CONTRIBUTIONS TO MATHEMATICS AND SCIENCE

## A Source Book in Greek Science

By Dr. Morris R. Cohen and Dr. I. E. Drabkin. (Source Books in the History of the Sciences.) Pp. xxi+579. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 54*s*.

"THE notion that natural science began in the seventeenth century with Bacon, Galileo, and Descartes, or perhaps in the sixteenth with Copernicus, and that the Greeks were mere speculators and the medieval thinkers all sunk in theology and superstition," state the compilers of this work, "is not merely an established popular error; it has become a basic dogma of modernistic philosophy and is even shared by professional historians. This error is largely supported by the prevailing type of specialized education, which trains students of nature to look at things exclusively from the point of view of current conceptions and does not sufficiently equip them with philological or historical methods to investigate how the world appeared to man at other times. On the other hand, historians trained in the humanistic tradition often fail to discriminate justly between genuine science and folklore. In any event, the scientist's interest in the nature of things and the historian's interest in the development of man's critical knowledge are all too seldom united. Such a union of interests, however, can be furthered by the study of the history of science. It is to serve this study that the present series of Source Books was inaugurated."

So far, source books in astronomy, mathematics, physics and geology have appeared in the series and have established a place for themselves; and there are few who would dispute the worthiness of the objective aimed at. For in the twenty years that have elapsed since the first volume was published, the education of the man of science has become increasingly specialized, which is to say narrowed; and often vocational training, admittedly in disguise, has encroached perilously upon learning. It is a sobering and indeed a frightening reflexion that teachers still active may, if this trend is not arrested, be faced before they reach the brink of their academic demise with a generation of undergraduates in science inspired with the faith that what is not in the syllabus is not in Nature. The remedy of prescribing wider studies in his own field in order to broaden a student's outlook is worse than the disease, which it aggravates; for it robs him of a leisure that he might put to better purposes. Happily, it is now becoming widely realized that the history of science can provide the humanistic element in scientific education; for, even if only a minority of

science students are interested in the general history of science, almost all are interested in the history of the science in which they are specializing.

This series of books, each with extracts from the classic works and memoirs of the founders of science, has given the student what he really needs in a handy and easily accessible form. The latest addition, a source book in Greek science, may well prove the most useful, not only to the student, but also to the general reader. The editors have cast their net widely and gathered almost six hundred pages of extracts with explanatory notes on mathematics, astronomy, mathematical geography, physics, chemistry and chemical technology, geology and meteorology, biology, medicine and physiological psychology. A detailed table of contents allows the reader to find quickly any topic in which he is interested in a period covering about a thousand years. There is at the end a valuable classified list of some important works on Greek science.

The section on chemistry and chemical technology includes translations from the Leyden Papyrus X and the Stockholm Papyrus, both of which may be described as 'Greek' only because they were written in that language, their content being derived from ancient Egypt; the translations made by Berthelot are more satisfactory than those quoted here.

It is a vast canvas, on which the contribution of the Greeks to mathematics stands out above all their other scientific activities; the reader soon appreciates how little understanding they had of experimental science and how far they are from us in that respect.

D. McKie

## PHOTOGRAPHIC EMULSIONS FOR RECORDING NUCLEAR PARTICLES

**Radioactive Measurements with Nuclear Emulsions**
By Herman Yagoda. Pp. ix+356. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 30s. net.

THE photographic (silver halide) emulsion has now been fully established as a tool as useful as the Wilson cloud chamber, ionization chamber, or Geiger counter in nuclear physics and radioactive studies, with the added advantage of simplicity, continuous sensitivity and permanent recording of the tracks of individual particles. Progress in the use of silver halide emulsions has been particularly rapid within the last few years, and there should be a demand, therefore, for a book which deals with the properties and limitations of the emulsion, together with a description of the numerous applications already devised.

Dr. H. Yagoda has attempted such a book and has collected together in one volume a large mass of experimental data, chiefly on the use of silver halide emulsions as alpha-particle or beta-particle detectors in radiochemistry, mineralogy, metallurgy, crystallography and biology, and the chapters on these subjects should prove very useful to anyone contemplating working, or already engaged in work, in these fields. Emphasis is on the experimental technique, and methods for producing suitable flat specimens are described in detail. The book has been designed primarily as a guide to the use of emulsions in radioactive measurements and provides an extensive survey of work in the above-mentioned fields, the bibliography alone including more than six hundred references. The final section of the book is a fairly brief survey of experimental techniques and results obtained with emulsions in nuclear physics.

The book loses much of its value, however, by the way in which the emulsion data and theoretical material are presented. These are scattered rather at haphazard throughout the book, sometimes under very misleading chapter headings. One would scarcely class, for example, the chemical reactions of emulsions with hydrogen sulphide or metals, and the effect of pressure, important as a knowledge of such effects is in order to prevent misleading interpretations of autoradiographs, under the general heading of "Photographic Detection of Nuclear Particles". The general properties of emulsions are described in Chapter 4, under the main heading of "Alpha Particle Patterns in Nuclear Emulsions". The most detailed description in the book of a nuclear emulsion is given on p. 255, which is somewhat delayed, considering the title of the book. Only the main chapter headings are given in the list of contents, and, as these headings are often vague, one has to rely on the index to look up any specific information; but owing to the scattering of related information throughout the book this process is not easy.

A knowledge of the dependence of the ionizing power of a particle on its velocity and charge, the range – energy relationships for the various types of particle in emulsions, and the variation in ionizing power along the path of a particle, together with the fact that silver halide grains in an emulsion can differ in size, sensitivity, concentration per unit volume and development-rate (fog), is essential in order to obtain a clear picture of why a particle may or may not give a recognizable track in a particular emulsion. Only by such an approach can the future applications of emulsions and their possible limitations be fully recognized. This does not seem to have been clearly realized by the author, with the result that the theoretical parts of the book tend to present a confused picture. Descriptions such as that which occurs on p. 249, where it is stated that the photographic action of gamma-radiation is due to the formation of secondary electrons in the sensitive film, and that the efficiency of this process is low, are also confusing. It is not the efficiency of the process which is low but the absorption of the gamma-rays. The expressions "photographic action of gamma rays" and "photographic action of beta-particles" (see p. 223) are in themselves misleading.

This sort of treatment leads to the arbitrary distinctions made between alpha- and beta-autoradiography, and between 'nuclear' and 'optical' types of emulsion. Emulsions utilize silver halide as the sensitive material, and the sharp division which is implied between 'nuclear' and 'optical' types is entirely artificial.

This book is the first of its kind and, in spite of the above criticisms, can be recommended as a survey of work already carried out with silver halide emulsions in radioactive studies; but it is suggested that it should be read in conjunction with a sound exposition of the properties and characteristics of emulsions when exposed to nuclear particles, such as that given by Webb in the *Physical Review* (**74**, 511; 1948).

R. W. Berriman

## Chemical Activities of Fungi

By Prof. Jackson W. Foster. Pp. xviii+648. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 9.50 dollars.

THE author of this book, who is professor of bacteriology in the University of Texas, defines its purpose as "to stress the subject matter from the standpoint of dynamics, that is, *transformations* [author's italics] effected by fungi". He states that it is designed primarily for the beginning student "with an eye toward the use of this book as a text for college courses at the upper-class or graduate level". He excuses his admitted omission of large and important aspects of the chemical activities of fungi by saying "it was done advisedly to keep the size of the book within bounds".

The nineteen chapters of the book contain the following headings: 1, introduction, history, perspective; 2, the methodology of mould metabolism; 3, chemical nature of the mould mycelium; 4, general considerations of mould metabolism; 5, natural variations; 6, mutations, physiological genetics, and biochemical syntheses; 7, trace element nutrition of fungi; 8, lactic acid formation by fungi; 9, alcoholic fermentation by moulds; 10, oxalic acid metabolism; 11, fumaric and other $C_4$-dicarboxylic acids; 12, citric acid; 13, itaconic acid; 14, kojic acid; 15, gluconic and other sugar acids; 16, carbohydrates produced by fungi; 17, nitrogen metabolism of fungi; 18, other transformations in fungi; 19, microbiological aspects of penicillin. The title of the book is inaccurate, misleading and too comprehensive. Little reference is made to modern work on mould metabolic products which have been described during the past twenty years and many of which have pronounced antibiotic properties. Most attention is paid, as will be clear from the contents, to the numerous theories, often mutually contradictory, of the mechanism of formation of a small number of old-established mould metabolic products. Further, there is little reference to any of the higher fungi, the subject-matter being confined almost exclusively to moulds.

## Deserts on the March

By Paul B. Sears. Pp. xi+181. (London: Routledge and Kegan Paul, Ltd., 1949.) 10*s*. 6*d*. net.

ALL but the last chapter of this book was written and printed in 1935, in the dark days in the United States after the 'famine years' of 1933 and 1934 had directed the urgent attention of the whole nation to the dangers of soil erosion. Later the problem was pushed into the background by the urgency of the War; now once again it is being appreciated as one of the great problems of human survival. Dr. P. B. Sears is professor of botany at Oberlin, Ohio, and he presents the picture with a greater scientific accuracy, a more pleasantly moving narrative and avoidance of the dangerous sensationalism of other writers.

Nevertheless, it is curious that he regards the natural cycle of erosion as destructive rather than one which balances construction with destruction. He seems also to regard man as everywhere destructive, failing to appreciate those areas where man has built up the soil. He regards the modern Italian as one of the best farmers in the world (p. 22) and rates highly European farming generally; yet he does not seem to draw the obvious deduction that a balanced mixed farming with the integration of crops and grass provides the answer he seeks. It is curious to find the acceptance of 150 million (to be reached in 1960) as the maximum population the United States can support, and sixteen acres of land per head (including three of ploughland) a minimum to maintain the American standard of living. We see here the still amazing contrast between the points of view of Great Britain and America, with the former having at present 1·2 acres (0·25 of ploughland) per head on which it is attempting to maintain its standard. It would be well to read Sir John Russell's presidential address to the British Association (see *Nature*, September 3, 1949, p. 379) side by side with this book.

Dr. Sears's remedy to secure good farming is to use taxation as both an incentive and a punishment—a solution of no little interest at the present time.

L. DUDLEY STAMP

## Brochure on Penicillin

By Dr. S. L. Bhatia. Pp. 171. (Ludhiana: Dr. S. L. Bhatia, Government College, 1949.) 1.8 rupees.

THIS is the second volume of the Indian Science Series, which seeks to give, in language which the non-specialist can understand, basic facts about progress in science and industry. After an introduction which briefly summarizes the chief conditions required for the production of penicillin, the author gives, in simple English words, an account of its discovery and its development during and after the Second World War. A description follows of the methods used for its manufacture on a large scale, and the author then discusses the characteristics of penicillin, its standardization and its pharmacological uses. A chapter on its marketing and storage precedes an appendix which discusses some recent developments. A list of references and an index complete a volume which many, who have no expert knowledge of penicillin, will find useful and interesting to read. The copy received lacks the illustration of penicillin crystals mentioned in the list of illustrations. The author believes that "the responsibility for the development and application of science in a democratic country rests ultimately with its citizens", and his aim has been to place, at a small cost, the knowledge of penicillin at the disposal of laymen, manufacturers, students and any others whom it may interest. He is to be congratulated on the production of this clear and very readable little book.

## Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 28. Pp. vi+121. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 15*s*. net.

THIS welcome annual continues to render valuable service to organic chemists seeking reliable methods for preparing a large variety of substances. The current volume adds thirty-seven preparations to the lengthy list, and there is a cumulative subject index covering Volumes 20–28. This index, taken in conjunction with those in the first and second collective volumes of the series, enables a quick reference to be made to any specific substance for which details have been given. Among interesting substances in the issue under notice are *trans*-1,2-*cyclo*hexanediol, hexamethylene chlorohydrin, 2-hydroxycinchoninic acid, *p*-nitrophenyl sulphide, and vinyl chloroacetate. As usual, the processes are based in the main upon methods already given in chemical literature, and here adapted and improved by one set of workers and checked independently by others. British organic chemists might well contribute in greater measure to this admirable publication.

J. R.

# A NEW APPROACH IN THE BIOCHEMISTRY OF GROWTH AND DEVELOPMENT

By Prof. J. N. DAVIDSON and I. LESLIE
Department of Biochemistry, University of Glasgow

A RECENT advance in our knowledge of the cell nucleus, of considerable interest in itself, promises in addition to become of major importance in the work of revealing the biochemical basis of growth and development. For some time it has been accepted that deoxyribonucleic acid is wholly confined to the cell nucleus in normal circumstances, and that it is one of the major components of the chromosomes. In 1948, Boivin, Vendrely and Vendrely[1] announced that they had found in the nuclei of somatic cells from animals of a single species constant amounts of this substance which were double those found in the corresponding haploid or sperm nuclei. These findings have since been confirmed and extended to a wider range of animals by Mirsky and Ris[2], and by Vendrely and Vendrely[3], whose latest work shows that the absolute values of deoxyribonucleic acid per nucleus fall within a compact group for a variety of mammalian species, and are appreciably different from those of, say, avian nuclei.

Thus we now have a nuclear component, which is a constant element of all normal cells of a given species and which lies at the centre of the metabolic life of the cells as part of the genes controlling their activities. In effect, it is a chemical unit which we can use as a measure of cell multiplication, and as a standard of reference by which we can reveal the changing metabolic patterns of cell activity in normal growth, differentiation, and the processes of regeneration and decay. The problems associated with growth are so extensive that it becomes necessary for the present to avoid a discussion in general terms, and to confine ourselves to the implications of the new approach as they appear in our first results of the chemical changes occurring both in embryo chick heart explants growing *in vitro*, and in tissues developing normally within the avian egg.

In biochemical studies of tissue-culture growth, we are first of all concerned with the measurement of the increases in the amounts of living material occurring under different experimental conditions. The methods available at present have been thoroughly reviewed by Cunningham and Kirk[4] who, finding them defective in one respect or another, proposed to measure culture growth by three parameters, the increase in cell number, the average change in cell size, and the volumes in which the cells existed at the various stages of growth. What we are proposing is in a sense the chemical counterpart of this method of analysing culture growth; and while it greatly simplifies the prob'm from the technical point of view, it does not, of course, eliminate the need for microscopical studies on the changing cell character or structure, which have been and will continue to be an important aspect of tissue-culture investigations.

The measurement of increasing cell number during growth in which the proportion of abnormal mitotic divisions is small or negligible now becomes a matter of determining quantitatively the changing deoxyribonucleic acid content of the cultures, using some such method as that of Schmidt and Thannhauser[5] for separating the ribonucleic acid from the deoxyribonucleic acid. The actual deoxyribonucleic acid (or ribonucleic acid) content can be based on the determination of the phosphorus present, or on measurements of the intensity of light absorption (at 257 mμ) due to the purine and pyrimidine components. The amounts of deoxyribonucleic acid then give us the relative increases in cell number with time, and if the actual amount of the acid per nucleus for the particular species in question is known, we can easily calculate the corresponding cell numbers. Table 1 shows the figures of cell increase, which have been obtained from chick heart explants growing *in vitro* over a period of six days. The calculation of cell number is based on the figure of $2{\cdot}62 \times 10^{-6}$ μgm. deoxyribonucleic acid per nucleus of the fowl erythrocyte found by Davidson and McIndoe[6], a figure which agrees closely with that of other workers, and which we must assume to be applicable to all the diploid somatic nuclei of the embryonic and adult organism. In this test we see that the cell number is doubled roughly every forty-eight hours over the last four days, a rate of multiplication which agrees with that found by Fischer[7] and others for the growth of chick heart fibroblasts in comparable conditions.

Table 1. Cell number in chick heart explants growing *in vitro*, based on deoxyribonucleic acid content of fowl nuclei as $2{\cdot}62 \times 10^{-6}$ μgm.

| Growth-period (days) | Deoxyribonucleic acid (μgm.) per 48 explants | Calculated cell number × $10^4$ |
|---|---|---|
| 0 | 7·00 | 2·7 |
| 2 | 8·50 | 3·2 |
| 4 | 18·40 | 7·0 |
| 6 | 35·70 | 13·6 |

In contrast to the differentiation of cells occurring in normal embryonic growth, the unorganised growth of cells in tissue cultures involves their reversion morphologically and biochemically to one of three main types[8]. Fischer[7] prefers to describe the process as one of dedifferentiation, in agreement with the conclusions arrived at by Olivo[9,10] in his studies on explanted heart tissue. It is fairly certain, then, that the growth of the chick heart explants used by us is accompanied by the 'dedifferentiation' of the myoblasts to a more primitive, or perhaps more generalized, type of cell. As we shall show later, there is at the same time a distinctive and regular pattern of chemical changes which may be related to their dedifferentiation. It is more usual, of course, in tissue-culture studies to work with pure strains of cells, in which complete reversion has been obtained by repeated sub-culturing. While the pattern of chemical changes in these will certainly be different from those occurring in our fresh explants, they will also have to be studied in relation to changes in growth-rate or in experimental conditions.

For these reasons we find it essential to investigate culture growth by recording two aspects of the process. The quantitative one, giving us an account of increasing cell number with time, has already been illustrated. For the second we use deoxyribonucleic acid as a standard of reference to reveal the changes in the relative amounts of other cell constituents. This gives us a view of the qualitative changes in

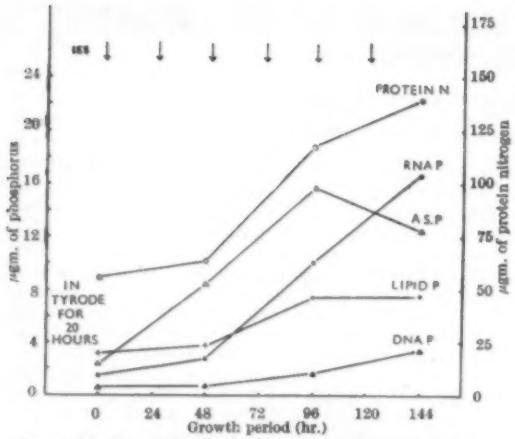


Fig. 1. Increases in chemical components of chick heart explants growing *in vitro*. Incubated embryo extract + serum replaced by fresh lots every 24 hours. Results show content per roller tube of 48 cultures. *ASP*: acid-soluble (10 per cent trichloracetic acid) phosphorus; *RNAP*: ribonucleic acid phosphorus; *DNAP*: deoxyribonucleic acid phosphorus

cellular composition as the cultures develop and respond to varying experimental conditions. The actual values relative to deoxyribonucleic acid will, of course, represent the mean composition of the cells, as individual cells at different points in the cultures are not necessarily in the same state of metabolic activity, and are therefore unlikely to be uniform in composition.

The chemical components determined in the tissue-culture studies have so far been confined to protein nitrogen, the acid-soluble phosphorus fraction, lipid phosphorus, ribonucleic acid phosphorus, and, of course, deoxyribonucleic acid phosphorus. As the cultures grow in plasma clot it has been necessary to modify the technique previously used by Davidson, Leslie, and Waymouth[11] to make possible the determination of nitrogen as well as the phosphorus fractions. Briefly, this involved increasing the number of cultures per roller tube to 48, reducing the film of plasma on the walls of the tubes to the very minimum required for the adhesion of the tissue, and incubating both the culture tubes and the plasma blanks, used as controls, in Tyrode-serum mixture for 24 hours at 37° C. following the period during which they were in contact with the growth-promoting medium. For the latter, we have obtained our most successful results (rapid culture growth and reduced plasma blanks) by departing from the usual procedure of preparing the medium from ice-cold and previously frozen chick embryos. Instead, guided by the demonstration of Earle *et al.*[12] that embryo extract, previously 'conditioned' by 24 hours contact with a growing culture, had a beneficial effect on culture growth from single cells, we have introduced the practice in our work of incubating the pulped embryos with Tyrode solution at 37° C. for 24 hours, before centrifuging and using the supernatant fluid (suitably diluted and with added fowl serum) as our growth-promoting agent.

The two aspects of the growth of heart explants are shown in Figs. 1 and 2. In the first the increases in the various components per forty-eight cultures are plotted against the time for which each group was in contact with the growth-promoting medium. While these increases are relatively large in all cases, it is clear that the individual components vary considerably in their behaviour during growth—in any event under our particular culture conditions. In Fig. 2 the same results are expressed in relation to deoxyribonucleic acid phosphorus, or, in other words, they are translated to show their relative amounts 'per cell' at different stages along the time-scale. The general trend here is obvious—after 48 hours there is a marked decrease in the protein nitrogen and the phosphorus fractions of the cells, with the exception of the ribonucleic acid phosphorus, which continues to increase up to 96 hours. It seems significant, too, that in this and other tests we have always found a fairly constant ratio between protein nitrogen and lipid phosphorus while their amounts per cell were changing. The close correspondence between the values of the ratio calculated from this set of cultures and from preliminary results obtained for the chick heart developing normally within the embryo from the eighth to nineteenth day of incubation is shown in Table 2. This demonstrates that

Table 2. Comparison of ratios of protein nitrogen to lipid phosphorus in embryo chick heart explants growing *in vitro*, and in chick heart growing normally within the embryo

| Chick heart explants | | Embryonic chick heart | |
|---|---|---|---|
| Growth-period (days) | Atoms of protein nitrogen per atom lipid phosphorus | Incubation age (days) | Atoms of protein nitrogen per atom lipid phosphorus |
| 0 | 39 | 8 | 28 |
| 2 | 36 | 10 | 32 |
| 4 | 36 | 11 | 26 |
| 6 | 41 | 13 | 32 |
| | | 15 | 34 |
| | | 17 | 36 |
| | | 19 | 34 |

there are certain quantitative similarities between the growth of explants *in vitro* and the normal growth of embryonic tissue. As will be seen later, the link between protein and phospholipid metabolism extends to other organs of the chick embryo. It is of interest here that Kosterlitz[13] found that, in livers of animals on low protein diets, loss of protein from the cells was accompanied by loss of proportional amounts of phospholipids.

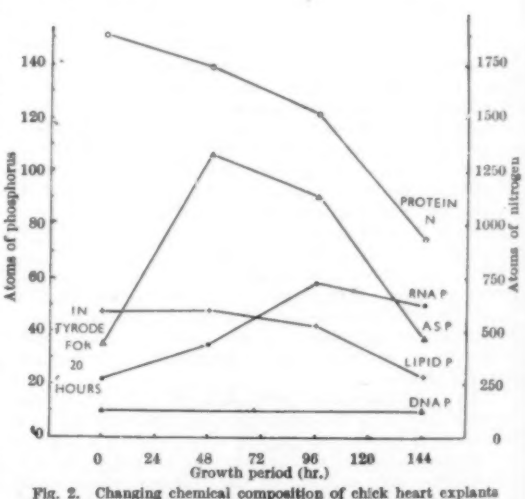


Fig. 2. Changing chemical composition of chick heart explants growing *in vitro*, as in Fig. 1. Chemical components expressed as number of atoms nitrogen or phosphorus relative to 10 atoms deoxyribonucleic acid phosphorus. *ASP*, etc., as in Fig. 1

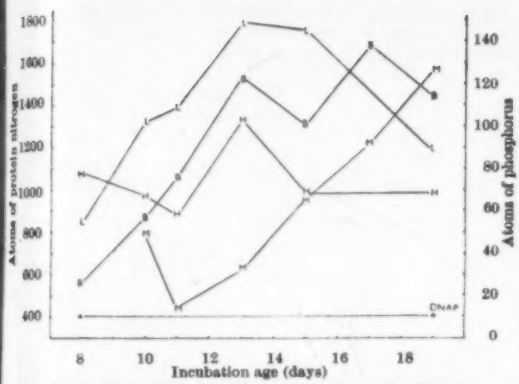


Fig. 3. Changing protein nitrogen content of embryonic chick brain (*B*), heart (*H*), liver (*L*) and muscle (*M*) relative to 10 atoms deoxyribonucleic acid phosphorus

The general pattern of chemical change, characterized by decreasing amounts of nitrogen and phosphorus fractions in the cells of the growing explants, has been found to hold for all the tests of this type. However, the quantities measured are very small, and it is likely that the absolute values of the ratios relative to deoxyribonucleic acid will require revision later as the tissue-culture techniques for biochemical studies are improved and as other methods for the determination of the nucleic acids are used in combination with phosphorus determinations. Recent tracer studies with phosphorus-32 by Davidson *et al.*[14] have revealed that associated with the ribonucleic and deoxyribonucleic acid fractions are small amounts of biologically active phosphorus which have hitherto been neglected. Although at present the accuracy of nucleic acid determinations based solely on minute amounts of phosphorus is open to question, the possible discrepancies are not so great as to invalidate the general trend of changes recorded in our cultivated explants.

We have tried to find whether the falling protein content of the cells in growing cultures is related to their reversion to a generalized cell-type by comparing it with the changes occurring in tissues which are certainly differentiating to their specific adult type. The preliminary work has been done on the brain, heart, liver and skeletal muscle (leg) of the chick embryo developing normally at 37–38° C., and the changes in the relative amounts of protein nitrogen per cell for these four tissues during the eighth to nineteenth day of incubation are shown in Fig. 3. At this stage the detailed fluctuations of the curves are not considered significant. What does clearly emerge, however, is the increasing content of protein nitrogen per cell for brain, liver and muscle over certain stages of their development—stages when the organs are growing rapidly and acquiring their functional powers prior to hatching. In contrast, there appears to be no regular increase in the protein content of the cells of the growing heart throughout the period investigated, and it may be significant that this organ has attained its final structural and functional form by the eighth day of the development of the embryo[15].

There is an apparent conflict between our finding that protein nitrogen increases per cell during periods of tissue differentiation and earlier evidence of decreasing relative amounts of protein nitrogen both in the whole chick embryo over the first four days of incubation[16], and in mammalian and avian brain tissues in their earliest stages of development[17,18]. In two of these studies the results were expressed as changes in relative concentrations and relative growth-rates, and in the case of the nervous tissue they were interpreted as showing that the tissue structure is at the start largely protein, and that the proportion of the latter decreases as lipoid and sterol molecules take their place in the nervous system[18]. It does not follow, of course, that the protein nitrogen is decreasing per cell (that is, relative to deoxyribonucleic acid) in these very early stages; but this is a possibility that can only be decided by further investigation.

Here we may perhaps speculate on the significance of these contrasting directional trends in the chemical development of growing tissue. Shall we find that differentiation of cells is accompanied by an increasing protein content of the individual cells, and that the variation in the other chemical components of the cells will follow a regular and reproducible pattern throughout the process of differentiation according to the nature of the tissues and their characteristic growth-rates? And will the process be similar but opposite in direction in the 'dedifferentiating' growth of freshly explanted tissues as our results suggest? For, if these trends should prove to be a general feature of metazoan growth, we shall have at our disposal a method of determining the developmental ages of growing tissues and their relation to morphological and physiological changes in embryonic growth, or, in the more compact field of tissue culture, we shall be able to study the factors which influence the rate of cell growth, and alter cell characteristics.

So far we have been discussing chemical changes in growth as events occurring at intervals along the chronological time-scale. But, if we are to reveal the fundamental chemical relationships in growing tissues, we must eliminate the complicating factors which are involved in recording chemical entities as variables along an external time-scale. This can be done by making use of the simple allometric (or hetergonic) relationship $y = bx^k$ first generally applied by Huxley[19] to describe the relation of the growth of a part or organ to that of the whole organism, and, later, by Teissier[20] and Needham[21,18], to the chemical development of a wide variety of animal organisms. As Needham[18] pointed out with reference to embryonic development: "A family of curves with meaningless shapes relating a chemical entity to age for several animals may become a series of straight lines of the same slope when the entity is logarithmically plotted against the totality".

In previous studies on the simple allometry of chemical entities, the latter have had to be related on a double logarithmic grid to the totality of the organ or whole organism, as represented by its wet or dry weights[20,21,22]. While these have revealed a widespread regularity in the behaviour of many chemical entities and groups, the significance of the actual growth-ratios is not clear since the totality itself is changing in composition, and contains as one of its variables the entity under investigation. In the case of a study of face-length against total skull-length in horses, Reeve and Huxley[22] came to the conclusion "that to plot a part against another dimension which includes that part will always tend to obscure change of proportions, and should generally be avoided".

Now that we know of a constant element of the cell nucleus, these complicating factors in allometric studies can be avoided, and we can find how the

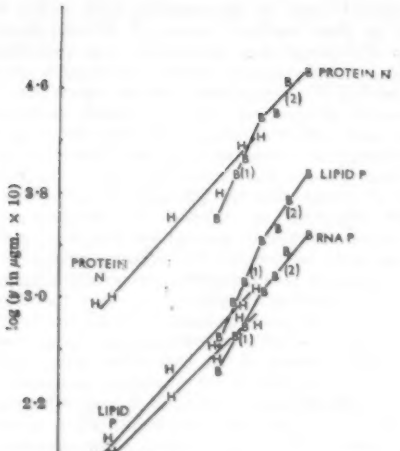


Fig. 4. Growth-ratios of protein nitrogen, lipid phosphorus and ribonucleic acid phosphorus relative to deoxyribonucleic acid phosphorus content of embryonic chick heart (*H*) and brain (*B*). Slope ($k = \tan \alpha$) of each line given in Table 3

growth-rates of chemical entities are related to those of a unit of the 'germ-plasm'. Needham[21] directed attention to the fact that when we plot the magnitude of chemical constituents of an organism against the magnitude of the organism as a whole, we are abstracting from morphological form, from the factors of nutrition, from the absolute values of the magnitudes, and from the time factor. By plotting instead against the deoxyribonucleic acid of the nucleus, we are carrying the abstraction a stage further, for we are, in addition, eliminating the influence of the changing chemical composition of the tissues from our results, in so far as it no longer obscures the significance of the growth-ratios. The deoxyribonucleic acid, of course, must depend on the chemical environment of the cell as a whole for its own characteristic growth-curve, and by using it as a standard of reference we reveal the changing phases of metabolic activity in developing organs and tissues. As similarities in the patterns of the relative growth-curves for different chemical entities are recognized, we shall begin to understand what Needham has called "the fundamental ground-plan of chemical growth".

Some of the first results we have obtained for the allometric relationships between various cell components and deoxyribonucleic acid phosphorus are shown in Fig. 4. Here we have plotted the logarithms of three entities of brain and heart taken from chick embryos against the logarithms of the corresponding amounts of deoxyribonucleic acid phosphorus found in the tissues. For these preliminary results the lines have been fitted to the points by eye on large-scale graphs, and their 'goodness of fit' has been tested by the graphical method of Kavanagh and Richards[24]. A striking correspondence can be seen between the growth-ratios (as represented by the slope $k = \tan \alpha$) of protein nitrogen, phospholipid phosphorus, and ribonucleic acid phosphorus in both organs, although the metabolic pathways in brain run quite a different course from those in the growing heart in the stages of development under comparison. In each case the growth-ratio for protein nitrogen is equal to or slightly larger than the corresponding growth-ratio for ribonucleic acid phosphorus, and this relationship also appears to hold for liver and skeletal muscle as illustrated by the values of $k$ of the growth-ratios set out in Table 3.

Table 3. Growth-ratios ($k = \tan \alpha$) relative to deoxyribonucleic acid phosphorus of chemical components of embryonic chick brain, heart, liver and muscle

| | Incubation period (days) | Protein nitrogen | Ribonucleic acid phosphorus | Lipid phosphorus |
|---|---|---|---|---|
| Brain (1) | 8–13 | 2·55 | 2·10 | 2·45 |
| (2) | 15–19 | 1·05 | 1·00 | 1·30 |
| Heart | 10–19 | 1·05 | 1·00 | 1·05 |
| Liver | 8–19 | 1·1 | 1·0 | 1·1 |
| Muscle | 12–19 | 1·4 | 1·1 | 1·25 |

Results from liver and muscle suggest that a change in the course of the growth-ratios may occur at about the same stage on the deoxyribonucleic acid phosphorus scale, but to a less obvious degree than the change found in brain tissue, and consequently the values of $k$ in the table are those for the lines which best fit all the points. When more results are available they may have to be revised.

These results make it evident that there is a definite quantitative relationship between the rate of protein synthesis and the rate of accumulation of ribonucleic acid phosphorus, and confirm the well-known views of Brachet and the Caspersson school that increasing concentrations of ribonucleic acid are associated with increased growth-rates and protein synthesis. They also show that phospholipid is in some way involved in the growth metabolism of proteins, but that it is more independent of protein nitrogen and ribonucleic acid phosphorus growth-ratios in nervous tissue, where it tends to accumulate rapidly in the cells in the later states of embryonic development. This deviation in the behaviour of brain phospholipid phosphorus becomes obvious when the latter is plotted logarithmically against protein nitrogen in chick heart, liver and brain (Fig. 5). The lines for

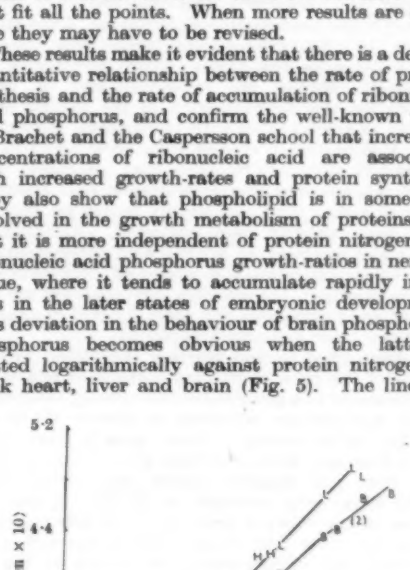


Fig. 5. Growth-ratios of protein nitrogen relative to lipid phosphorus in embryonic chick brain (*B*), heart (*H*) and liver (*L*) over incubation period 8–19 days. Growth-ratios ($k = \tan \alpha$) as follows: heart and liver, 1·0; brain (1), 0·95; brain (2), 0·85

heart and liver coincide (or lie very close together), whereas the points for brain are best fitted by intersecting lines which lie some distance away from the other two.

We have used these early results of our chick embryo studies to illustrate how the comparison of growth-ratios of certain chemical entities to the deoxyribonucleic acid phosphorus of the nucleus can reveal the quantitative relationships between individual entities and the changing metabolic pattern corresponding to the stages of development of the tissues. By plotting afterwards one entity against another on the double logarithmic grid, we are better able to decide whether or not they are metabolically related in the same way in all tissues. We cannot, of course, determine which is the precursor and which is the dependent entity; but a combination of the methods described above with suitable tracer techniques[25] may yet enable this to be done.

We wish to thank Mr. S. W. Morrison for helpful advice and to acknowledge that one of us (I. L.) is an Imperial Chemical Industries research fellow; and that this work was supported by a grant from the Medical Research Council.

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## UNIVERSITY DEVELOPMENT IN BRITISH COLONIES

THE second report of the Inter-University Council for Higher Education in the Colonies, covering the period 1947–49*, provides a record of work of real significance for the future of the British Commonwealth. The adoption by Great Britain of a policy of trusteeship towards the Colonial dependencies carries with it the obligation to train the native populations for ultimate self-government. The attainment of this object must depend to a great extent upon an adequate supply of highly educated and well-trained local people capable of carrying the responsibilities and bearing the burdens which self-government involves. The economic development of the territories and the social services require a vast increase over the number of trained personnel at present available. Administrators, medical men, dentists, engineers, agricultural experts, teachers of all grades, technicians of all kinds are needed in ever-growing numbers. The effectiveness of the steps taken to provide them is a measure in the eyes of the native peoples of the sincerity of the efforts being made to fit them for self-government; the good-will of these peoples and so, perhaps, the ultimate retention of the territories within the Commonwealth, will depend in no small degree upon the progress made in this direction.

Outstanding among these efforts is the setting up of university institutions to serve the various territories. The report under review sets forth what has been done in this respect, and it is indeed a most remarkable record of rapid progress. Within the last two years a University, formed by the union of Raffles College and the King Edward VII College of Medicine, has come into being at Singapore; university colleges have been established in Nigeria at Ibadan, in the Gold Coast at Achimota, at Khartoum in the Sudan and near Kingston in Jamaica; and Makerere College in Uganda is expected to achieve university college status in the near future and to serve eventually as the university for East Africa. The Universities of Malta and Hong Kong are, of course, of much longer standing.

In the new institutions the establishment of proper university standards is all-important, and none is more keen in this matter than the Colonial peoples themselves. They are determined to be satisfied with nothing less than the standards of British universities. It is essential that the degrees of the eventual Colonial universities shall be recognized in Great Britain, so that no difficulties will arise in the admission of Colonial graduates to postgraduate courses in British universities. Further, the dangers of flooding the countries with large numbers of more or less unemployable sub-standard graduates is fully recognized. To safeguard the position, the university colleges have entered into 'special relationships' with the University of London, which has modified somewhat its external examination system to deal with the situation. Before admitting a college to this 'special relationship', London satisfies itself as to its autonomous character, academic control of academic policy, the suitability of the staff for teaching and research, an adequate range of subjects, proper library and laboratory facilities and suitable provision for a student corporate life. When admitted, the college staff works in close co-operation with the London authorities in matters of syllabus and examination requirements, and participates in the actual examination of its students. The degrees awarded are those of the University of London, which in this way guarantees their standard, while at the same time the disadvantages of an external degree system are minimized.

The new Colonial university institutions must inevitably be at some disadvantage at first owing to their isolation and distance from other centres of learning. To meet this problem, at least in part, the Inter-University Council has arranged for frequent visits by its members to the colleges. The Council has also representatives on the various governing

* Colonial Office. Inter-University Council for Higher Education in the Colonies. Second Report, 1947–49. (Cmd. 7801.) Pp. 18. (London: H.M. Stationery Office, 1949.) 6*d.* net.

bodies, the meetings of which its members attend. Members of the University of London have also paid visits in connexion with the development of the scheme of 'special relationships'. This frequent intercourse with the home universities has proved invaluable in assisting the progress of the colleges, smoothing out difficulties, promoting co-operation and removing the sense of isolation. A further important service has been rendered by the Inter-University Council by its appointment of a library advisor, whose office in London has already become an important centre of information and advice. In the preparation of book-lists, the supply of information on micro-films and other technical matters, procuring sets of periodicals, advice on buildings and furniture, on binderies and library organisation, much help is asked for and given.

One of the most difficult and pressing problems experienced by all the new colleges is naturally that of staffing. The ultimate success of these new institutions will depend predominantly on the quality of the staff appointed, particularly in the early stages of their existence. The Inter-University Council, with the active co-operation of the home universities, has expended much effort in meeting the demand. A large measure of success has attended this work, though there are many important posts still unfilled. It is good to know that the policy of the Council is not to fill a post at all rather than to appoint an individual not up to the necessary university standard in teaching and research ability. It had been hoped to make a considerable number of appointments by secondment for limited periods up to three years of members of home universities. A few such have been made, but there is room for many more. Such appointments, it may be remarked, should benefit in the long run the seconding as much as the receiving universities.

A welcome start has been made in associating research institutes with the nascent universities in accordance with the policy of the Colonial Research Committee. Institutes of Economic and Social Research have been set up at the University College of the West Indies, at Ibadan and at Makerere College. Departments of extra-mural studies have also been established in the West Indies, the Gold Coast and Nigeria. These should have a great influence in spreading enlightenment throughout all social classes in the territories and do much to hasten their general progress.

All these developments are, of course, costing much money. The distribution by way of block grants by the Colonial University Grants Advisory Committee of £6 millions provided by the Colonial Development and Welfare Fund, the generous grants made both for current and capital expenditure by the local governments concerned, and the further direct financial support, often on a large scale, by the Colonial peoples themselves, the establishment of scholarships by local authorities and private associations, and numerous benefactions both in money and kind, all would appear to ensure a satisfactory financial future.

There can be no doubt that, though there must be difficulties and teething-troubles ahead, yet in the words of the report, "something has come alive in the Colonies in these past two years on which the hopes of many people rest". The Inter-University Council may be well satisfied by the part it has played in this highly significant development.

B. Mouat Jones

# EDINBURGH CONFERENCE ON ELEMENTARY PARTICLES

THE Department of Natural Philosophy of the University of Edinburgh arranged a conference on elementary particles, to take advantage of the presence in Scotland of Prof. Niels Bohr, who has given this year's Gifford Lectures. The conference took place during November 14–16, with a full programme of lectures both experimental and theoretical. In this brief report of the proceedings it will not be possible to do justice to all of the speakers taking part.

In the experimental section of the programme, Prof. N. Feather, of Edinburgh, described various attempts to detect the presence either of negatively charged protons or of neutral particles (dineutrons) of double the mass of a neutron. It was considered that if such particles exist at all in Nature, then one might expect to find them among the radiations emitted in fission or by short-lived fission products. A typical experiment was one carried out by Fenning at Harwell, exposing bismuth to an intense neutron flux in a pile. In this case neutron and dineutron capture will produce beta- and alpha-activity respectively, and the conditions are favourable for detecting the alpha-activity even in very small intensity. The results of this and other experiments have been entirely negative. Dr. B. Zajac and Dr. M. A. S. Ross described experimental work which is in progress at Edinburgh in the field of cosmic rays, using the photographic plate technique. They have developed an accurate and rapid method of calibration to determine the relation between grain density and specific ionization in a particular plate; they use for this purpose the tracks of electrons which come to rest in the emulsion.

Five other experimental talks were given dealing with cosmic rays: by Dr. J. G. Wilson of Manchester, Dr. B. Pontecorvo of Harwell, Dr. D. H. Perkins of Imperial College, London, Prof. LePrince Ringuet of Paris and Prof. C. F. Powell of Bristol. Dr. Perkins has studied the heavier fragments which are emitted in stars in photographic plates. The statistics are not yet good enough for trustworthy conclusions to be drawn, but it appears that a surprisingly large proportion of large fragments are emitted with relatively high velocities, the average velocity increasing with the charge of the fragment. It is difficult to understand how fragments come to be emitted with such high kinetic energies, and yet with internal excitation energies which are not great enough to cause complete disruption. Dr. Perkins suggests that the explanation may be found in the very high angular momenta which may be given to a heavy nucleus by the impact of a relativistic nucleon striking to one side of the centre of gravity. If the residual nucleus is left with a moderately large excitation energy, and with 20 or 30 units of angular momentum, then the emission of fast heavy fragments may be favoured as the most effective means of disposing of the angular momentum.

Prof. LePrince Ringuet exhibited some slides showing giant stars, in which twenty or thirty lightly ionizing tracks are seen emerging in a bundle from one side of a nuclear disintegration. Such events are *prima facie* evidence of the multiple production of mesons in a single act. However, after some discussion, it was agreed that the evidence is not conclusive, and an interpretation in terms of plural

(successive) production of mesons in many individual nucleon–nucleon encounters inside the nucleus is still possible. In this connexion, Prof. L. Jánossy of Dublin presented an analysis of some experimental data obtained at Bristol, consisting of some two hundred pictures of stars with more than two lightly ionizing tracks. He showed that the experimental statistics of such tracks, including three cases of stars with more than sixteen light tracks, can be well accounted for by a hypothesis of purely plural production, using a phenomenological theory with a reasonable assumed cross-section for the production of a single meson in a single nucleon–nucleon collision. It appears that the issue of plural versus multiple production will only be decisively settled by experiments involving the production of mesons in hydrogen. In conclusion, Prof. LePrince Ringuet described an experiment to measure the masses of fast penetrating particles with a mass-spectrometer consisting of a cloud-chamber in a magnetic field combined with a suitable arrangement of absorbing plates and counters, similar to the apparatus of Alichanov, Alichanian and Weissenberg. He found no evidence for masses different from those of the well-known types of particle. He observed that protons which suffer nuclear collisions in the absorber might easily be interpreted as 'varytrons'.

Prof. C. F. Powell presented a more extensive analysis of the masses of fast particles, carried out at Bristol and based on a large number of exposures of minimum-ionization-sensitive plates at various altitudes. Two methods of mass-determination have been used, giving results which are generally in agreement. First, the small-angle scattering has been accurately measured for all tracks having a length of more than 3 mm. in the emulsion; combined with specific ionization measurements, this determines the masses of particles at non-relativistic velocities, and sets an upper limit for the masses at relativistic velocities. Secondly, Franzinetti has made observations at the Jungfraujoch with two emulsions facing each other and separated by an air-gap, the whole assembly being maintained in a magnetic field of 30,000 gauss; the deflexion of a particle in this field as it crosses the air-gap, together with its range in the emulsion, yields a measure of its mass. The results of these experiments may be summarized as follows. (i) Of all fast tracks, 98 per cent are identified as having masses corresponding to known particles. The remaining 2 per cent, which might be interpreted as $\tau$-mesons, should probably be attributed to the effects of large-angle scattering or other instrumental errors. No new examples have been found of the peculiar types of disintegration which gave rise to the original postulation of the $\tau$-meson. (ii) Let a 'shower particle' be defined as a particle coming out of a star and giving a track with less than one and a half times minimum ionization. Then at least 80 per cent of shower particles are $\pi$-mesons. Also, a considerable proportion of the fast ionizing particles seen entering and presumably causing stars are $\pi$-mesons. (iii) Of the fast tracks seen coming out of stars, all are either $\pi$-mesons or protons. No $\mu$-mesons are seen, and no electrons.

Other observations reported by Prof. Powell were the following. (i) 500 examples of $\pi - \mu$ decay observed at the Jungfraujoch were analysed to see whether the $\mu$-tracks showed any directional asymmetry, such as Wentzel has suggested might occur if the $\pi$-meson has a spin, in view of the predominantly vertical orientation of the $\pi$-producing nucleon beam. No asymmetry was detectable, a result which, of course, does not exclude the possibility of a non-zero spin for the $\pi$-meson. (ii) Many tracks have been measured of electrons with energies greater than 100 MeV., and all have grain densities less than 1·1 times minimum; thus the theoretically predicted relativistic increase of ionization with energy does not appear to exist. Dr. J. G. Wilson suggested an explanation: the relativistic increase of ionization is supposed to be due to atoms at large distances from the moving particle, in a region where ions will be formed only sparsely and with small energies; thus if the photographic grains respond not to single ions but to groups of ions close together, the extra ionization produced by a highly relativistic particle will not produce a corresponding increase in grain density. (iii) Using an analysis of small-angle scattering, King at Bristol has measured the energies of electron–positron pairs which are generated in plates at high altitudes by photons of the soft component; in a large stack of plates, the frequency of such pairs increases with depth in the stack, so that a considerable proportion of the originating photons are locally generated, and it may be presumed that these photons arise in part from nuclear collisions in the upper layers of the stack. The observed energy distribution of the pairs has a maximum at about 100 MeV., falls off rather steeply below this maximum and more gradually above it. Such a distribution is pleasantly suggestive of a neutral meson of mass 300, which is created in nuclear collisions and decays at once into two photons. However, these observations are still at a preliminary stage. (iv) Numerous examples have been found of the so-called 'giraffe' events (nomenclature due to Occhialini) in which one relativistic track suddenly splits into three relativistic tracks with very small angular divergence. From scattering measurements, it is found that there is a rough energy-balance between the one ingoing and the three outgoing tracks; also the rest-masses of all particles involved are of the order of the electron mass. The frequency of these events seems much too great for them to be explained as pair-creations due to an electron passing through the field of an atom. They remain a mystery, about which it is hoped more will be heard.

In the theoretical section of the programme there were three talks describing the work of the Edinburgh school, one by Prof. Max Born himself, one by Dr. L. M. Yang and one by Dr. Kai-Chia Cheng. These talks gave a general account of the reciprocity theory of elementary particles which Prof. Born has originated. The theory aims at providing, at one blow, a consistent formalism free of divergences for the description of quantized fields, and an explanation of the various types of existing particles and their masses. Since the theory is yet by no means in a complete form, the conference was not in a position to pass judgment upon it. Because of its technical mathematical character, no attempt will be made to summarize it here.

Prof. Niels Bohr gave a talk on the theory of elementary particles, in which he described the ideas and methods which were followed in the analysis of the concepts of quantum electrodynamics which he has recently completed with Prof. L. Rosenfeld. The result of this analysis has been to show that the concepts of quantum electrodynamics form a logically consistent and intelligible framework. This makes the future task of the theoretical physicist more difficult rather than easier, because it is now clear that

the real problems concerning the nature and existence of elementary particles cannot be met and attacked within the domain of electrodynamics.

Other theoretical papers were read by Prof. F. Bopp of Munich, Prof. L. Jánossy of Dublin, Prof. M. Fierz of Basle, and by Sir Charles Darwin. Prof. Bopp presented a new method for formulating the dynamics of particles interacting with an electromagnetic field, when the Lagrangian of the system involves not only particle velocities but also accelerations; he is able to quantize this formalism, and to obtain from it various elegant consequences; however, the quantized theory is not yet completely worked out and adapted for practical use.

At the end of the theoretical programme, Sir Charles Darwin put forward some radical speculations concerning the origin of cosmic rays, which aroused widespread discussion. He first proposed for consideration the phenomenon of pitting of marine propeller-blades as a result of cavitation at the surface of the blades; in this phenomenon a small hemispherical cavity in the water is supposed to collapse in a symmetrical manner, and it follows from the laws of hydrodynamics that a very small mass of water in contact with the blade will arrive at the centre of the cavity at the instant of collapse with an immensely high velocity. He suggested that the origin of cosmic rays be sought, not in any thermodynamically stable process, but in some violently non-thermodynamical and co-operative phenomenon such as he had described. Pushing a little farther the analogy with cavitation, he proposed for investigation the possibility that cosmic rays could be generated in the collapse of large vacuous regions formed by the turbulent motions in stellar atmospheres [see also *Nature*, December 31, p. 1112]. Sir George Thomson, however, pointed out that because of the well-known order of magnitude of the cosmic-ray flux, either the generation process in stars must be unreasonably efficient, or else the generation must be taking place in our own sun.

Present at the conference were about a hundred physicists, representatives of ten countries. Russian physicists, who also had been invited to attend, were absent. However, at one of the sessions Prof. Born read a telegram which he had received from Prof. Vavilov, president of the Academy of Sciences of the U.S.S.R., apologizing for not sending a delegate and expressing friendly interest in the proceedings of the conference.

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# OBITUARIES

## Prof. D. R. Hoagland

THE death of Dennis Robert Hoagland, professor of plant nutrition in the University of California, Berkeley, has removed an illustrious plant physiologist and one of the world's leading authorities in the broad field of plant and soil interrelations. For more than thirty years he laboured with distinction and devotion toward the understanding of the extremely complex plant–soil–atmosphere system as it exists in Nature.

Hoagland was born in Golden, Colorado, and received his early education in Denver. In 1903 he went to study chemistry at Stanford University. Following a distinguished undergraduate career he first elected to go on with advanced work in chemistry; but in 1908 he accepted a position in the Laboratory of Animal Nutrition in the University of California. The new position brought him for the first time in professional contact with biology and took him to Berkeley, where, except for a few short gaps, he was to spend the rest of his life.

Hoagland remained in the field of animal nutrition for five years, the last of which he spent in research under Prof. E. V. McCollum, of the University of Wisconsin. In later years, Hoagland looked back on his association with Prof. McCollum as his real inspiration for a life devoted to scientific research. There would normally have been every expectation that he would continue in this field, but circumstances intervened and the acceptance in 1913 of a position as assistant professor of agricultural chemistry brought him back to Berkeley and was the initiation of his work in plant nutrition.

One of his early research activities concerned itself with the effect of hydrogen-ion concentration on plant growth. It was with great surprise that he discovered that, contrary to the then accepted tenets of agricultural teaching, barley plants made excellent growth at *p*H 5. It was apparent that the inherent complexity of soils rendered untrustworthy many sweeping generalizations based on local conditions. He became convinced that the complex problem of soil and plant interrelations could best be studied by techniques which permitted rigid experimental control and the isolation of individual variables. He afterwards developed to a very high degree the water-culture technique for growing plants which has since, for more than three decades, served as a powerful and discriminating tool for studying fundamental problems in plant physiology at Berkeley. In later years he was also instrumental in securing one of the first experimental chambers in the United States for the growing of plants under reproducible conditions of light, temperature and humidity.

His early and dominant research interest was in the process of absorption and accumulation of ions by plants. The quality of the immense contribution which he, with his collaborators and associates, made to this fundamental process of plant physiology can only be judged against a background of the ideas and concepts which prevailed when his work got under way. There was no clear view as to how inorganic elements are absorbed by plants. Discussions of this subject were usually invoking such concepts as osmosis, permeability, antagonism, none of which, as he later clearly demonstrated, could explain their absorption, accumulation and retention against a concentration gradient of anions and cations by plant cells.

Hoagland first became interested in the special nature of ion absorption by plants during the First World War, when during a search for domestic sources of potassium, he discovered the remarkable ability of the giant kelps of the Pacific Coast to accumulate potassium and iodine many times in excess of the concentrations found in the sea. He returned to this problem several years later, using first intact barley plants and, later, a unicellular freshwater alga, *Nitella*. This work clearly demonstrated that absorption of ions by plants is a metabolic process requiring energy and not a question of simple permeability. His work with *Nitella* allowed him to paint in bold strokes a theory which at once correlated a host of observations in the field and laboratory and made it possible to approach an infinitely complex subject with principles instead of mere empirical observations. The next phase of his researches on

ion accumulation brought him closer to the system which was uppermost in his mind—the absorption of nutrients by the roots of higher plants. Using excised barley roots of known and reproducible physiological status, an impressive array of results was amassed on the influence of light, temperature, *p*H, ion selectivity, concentration of ions in the external medium, differences in rates of absorption and the effect of one ion on the absorption of another. A striking correlation was obtained between the supply of oxygen and the absorption of salts by roots against a concentration gradient. A solid scientific foundation was thus laid for the understanding of the importance of aeration in soils and for the interpretation and prediction of a multiplicity of plant responses to fertilization treatments and other chemical changes in the soil. The final phase of his investigations on absorption of ions occurred just before and during the Second World War, when many of his earlier conclusions were confirmed and extended with the use of the sensitive technique of radioactive isotopes.

Dominant as his life-long interest in the process of ion absorption was, it by no means prevented him from pursuing with vigour other phases of plant nutrition to which he, with his associates, made outstanding contributions. He studied by means of different techniques, including some of the earliest application of radioisotopes, the upward movement and distribution of inorganic solutes in the plant. He was keenly interested in problems of soil chemistry in so far as they affect the nutrition of crops grown in the field. His own work was especially concerned with zinc, potassium and phosphate deficiencies of fruit trees in California. He contributed to the identification of one of the most important physiological diseases of fruit trees in California, 'little leaf', with zinc deficiency, and reproduced it under controlled greenhouse conditions. His investigations of potassium nutrition had a bearing on 'prune dieback', another nutritional disease of fruit trees in California, and led to extended studies of the chemical aspects of potassium availability in soils. His interest in the nutrition of fruit trees continued, and in 1940 he produced, under controlled conditions, the first molybdenum-deficiency symptoms in a fruit tree species.

Hoagland's entire life as a productive scientific worker was spent in association with agricultural research. He had a profound faith in the importance to agriculture of fundamental research, without thought and expectation of immediate practical returns. He was fully aware of the often wide gap between laboratory result, obtained under controlled conditions, and the field application, complicated as it is by a multiplicity of factors. He was conscious not only of the promise but also of the limitations of science in agriculture. In dealing with living plants and animals he was mindful that "it still takes the wheat plant six or nine months to develop and cows bring forth their calves neither more quickly nor more numerously for us than they did for Abraham". He believed that the contribution of science to agriculture must be judged not only by its material achievements but also by the enlightenment it proffered to the farmer and city dweller alike about the intricacies of plants and soils. Though a chemist by training, he acquired early the outlook of a biologist and was mindful of the inherent complexity of biological systems, their adaptive properties to varying conditions, and hence he distrusted the spectacular short-cut or facile generalization unless it was supported by solid experimental evidence.

Hoagland's chief characteristic, whether in scientific matters or personal relationships, was integrity and objectivity of outlook. In evaluating scientific evidence he had the "four things" which Socrates said "belong to a judge: to hear courteously, to answer wisely, to consider soberly, and to decide impartially". He applied the same critical standards to his own work as to that of others. He accepted no blanket authority in science, and expected every single piece of research to stand on its own merits regardless of its source. In personal relationships he possessed the engaging quality of always seeking the good in men and their work. In approaching students, he had a rare gift of making them sense the good-will and confidence in their ability with which he always credited them at the start. His students were spurred to special efforts by a desire to prove themselves worthy of his trust. Hoagland's confidence and friendship once given were not easily withdrawn. Never demonstrative in manner, he had a deep loyalty and an unfailing concern for the welfare of his friends and associates.

Hoagland was the not altogether common scientist who carried the scientific mode of thinking outside his own speciality into diverse areas of human thought and achievement. He maintained an active interest not only in many departments of science but also in fundamental questions of education and in the social and political problems of the contemporary scene.. It was a stimulating experience to witness his well-stocked mind analyse a complex issue with clarity and insight which unerringly penetrated to the root of the matter. Whatever the subject may be, his discussions had a special flavour of emotional and intellectual maturity which excluded bias and preconceived notion. In the seventeen years during which I was associated with him as a student, colleague and friend, I never once heard him discuss a person or an issue, scientific or otherwise, except in a fair and objective manner.

It is only natural that his accomplishments, his qualities of mind and character gained him wide recognition and many honours. His counsel was sought and valued within his own University, to which he gave unstintingly of time and effort in many arduous administrative assignments, usually at the expense of his own leisure and in later years at the expense of his health. In 1934 he was elected a member of the National Academy of Sciences. The American Society of Plant Physiologists, which was his closest scientific affiliation, bestowed upon him its highest honour by granting him, in 1929, the first Stephen Hales award in recognition of his outstanding research contributions. He was also elected president of the Society and occupied other important offices in it.

The high esteem in which he was held by plant physiologists throughout the world is attested by his recent appointment as president of the Section of Plant Physiology at the forthcoming Seventh International Botanical Congress to be held in Sweden in 1950. Unfortunately, poor health forced him to decline this international honour.

Many other societies in which he held membership honoured him in various ways. In 1940 the American Association for the Advancement of Science awarded him the 1,000 dollars prize for an outstanding paper presented at the Philadelphia meetings. In 1942 he was invited by Harvard University to give the John

M. Prather lectures. The lectures were later published in book form, and constitute the only book which he found leisure to prepare.

His own colleagues in the various faculties bestowed upon him the highest honour within the University, by appointing him faculty research lecturer in 1942.

Hoagland was never in robust health; but a strong sense of duty compelled him to carry on without a thought for his own personal well-being. The last four years of his life were marred by serious illness. He carried on with courage and determination to within the last few months of his life, when his eyesight failed him almost completely. This latter blow was the severest of all, for throughout his life he enjoyed reading on a wide variety of subjects. It was characteristic of the man that once he gave up hope of regaining his health he requested retirement from the University, ignoring the serious financial adjustment that such a voluntary step would involve. He was officially retired on July 1, 1949, and died almost two months later.

In 1920 he married Jessie A. Smiley. She died suddenly of pneumonia in 1933. He was left with the responsibility of bringing up three young boys. His three sons, his mother and a brother survive him.

The scientific influence of Prof. Hoagland's life has not come to an end with his death, but will continue through the deep impression which he made on the minds and hearts of his students and friends.

DANIEL I. ARNON

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WE regret to announce the following deaths:

Mr. Joseph Bailey, formerly of the Ministry of Education, sometime president of the Museums Association, on January 4, aged eighty-nine.

Dr. Isaiah Bowman, president since 1935 of Johns Hopkins University, on January 6, aged seventy-one.

Prof. Stefan Meyer, one of the pioneer workers in radioactivity and for many years director of the Vienna Radium Institute, on December 29, aged seventy-seven.

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# NEWS and VIEWS

## Wool Industries Research Association: Dr. A. B. D. Cassie

THE announcement that Dr. A. B. D. Cassie has been appointed director of research of the Wool Industries Research Association will be received with satisfaction by his many friends in academic and industrial life. A graduate in mathematics and physics of the Universities of Edinburgh and Cambridge, he first carried out research in Prof. F. G. Donnan's laboratory at University College, London. In conjunction with C. R. Bailey, he published some twenty papers on the infra-red spectra and structure of triatomic molecules, and then in 1934 joined the staff of the Dyestuffs Division of Imperial Chemical Industries. During the following two years, he introduced dielectric and power-loss methods of indicating the state of aggregation of fillers in rubber, and then transferred to the Royal Aircraft Establishment, where he worked with Sir Ben Lockspeiser until his appointment as chief physicist at the Wool Industries Research Association in 1938. Since that time his special interest has been the adsorption of water vapour by textile fibres. After studying the simultaneous propagation of heat and water vapour through hygroscopic textiles, which provided a clear indication of the physical properties associated with the warmth of clothing, he made an important contribution to the theory of water adsorption by textile fibres by giving the first statistical derivation of Brunauer, Emmett and Teller's adsorption isotherm. More recently, he has devoted his energies to water-repellency, and his elegant work in this field, by directing attention to the importance of surface structure, has served to explain several unusual phenomena associated with plant and animal surfaces. For these and other investigations he was awarded in 1946 the Warner Memorial Medal for investigations in textile technology. Dr. Cassie succeeds Mr. B. H. Wilsdon as director of research during a period of expansion of the buildings and equipment of the Research Association, and their previous close association will ensure continuity of development during a critical phase in the history of the wool textile industry.

## Research on Cortisone and Related Substances at Oxford

IN *Nature* of December 31, p. 1117, it was announced that the Nuffield Foundation had made a grant to the University of Cambridge for research on adrenocorticotropin in pursuance of the special interest it has shown in work bearing on the causes and cure of rheumatism. A parallel grant, of £10,000, has also been made to the University of Oxford for a study of the synthesis of cortisone and its analogues in the Dyson Perrins Laboratory under the supervision of Sir Robert Robinson. Although it is probable, as Sir Robert has himself stated in his presidential address to the Royal Society (*Nature*, December 17, p. 1025), that synthesis of Li's peptide hydrolysate of adrenocorticotropic hormone offers the better approach, the attack on cortisone itself must also be made. The problem is one of great difficulty, and the preparation of cortisone has hitherto been effected only from material of natural origin, such as the desoxycholic acid of bile. This is hopeless for large-scale working and is said to require no less than thirty-five stages. Synthesis from a plant sapogenin, namely, sarmentogenin, about halves the number of stages, but this also is an unattractive proposition. The complete synthesis seems a more or less hopeless quest, but it is hoped at Oxford to make two kinds of substitutes. The first would be a near analogue such as might result from work among molecules rather closely related to cortisone. The second would be an analogue in which the cortisone structure is simulated in a much simpler structure. In other words, one objective of research is to find the substance that will bear the relation to cortisone that stilbœstrol bears to œstradiol. The feasibility of this cannot be assessed at this time, because we do not know how narrowly specific may be the constitutional–physiological relationship.

## Tsetse Control in the Gold Coast

DR. KENNETH MORRIS has been appointed director of the newly established Tsetse Control Department, Gold Coast; this Department has arisen out of the trypanosomiasis campaign, which was an offshoot of

the Medical Department. In view of the ramifications of the tsetse problem, touching on the activities of many departments, including those of agriculture and veterinary and medical work, it was felt that it must now be attacked on the broadest lines by proper land planning and land utilization in order to achieve permanent results. Sleeping sickness has now been brought under control in the Gold Coast, and this success requires consolidation by settlement and mixed farming, with consequent attention to trypanosomiasis of domestic animals. Large-scale research and experiment on the control of *Glossina morsitans* in particular are in progress, together with the epidemiological studies necessary for the planning of control operations. An article on tsetse control (by Dr. Morris) was published in *Nature* of December 31, p. 1114.

## Imperial College of Tropical Agriculture, Trinidad : *Newsletter*

THE Imperial College of Tropical Agriculture, St. Augustine, Trinidad, issued in October 1949 the first number of a *Newsletter*, a modest publication of three sheets, the object of which is to impart frequent up-to-date information about current College happenings and affairs. The publication is circulated to appropriate government departments, other official bodies and commercial concerns and to the local press and other public information services. The first part is devoted to staff changes and appointments. The next section deals with student notes, from which it is learned that there are fifty-six students now in residence, of which thirty-six are undergraduates studying for the diploma of the College, and twenty are postgraduates entered for the associateship of the College or the diploma in tropical agriculture (Trinidad) or attending special courses. The bulk of the students come from the British West Indies, but some are from other parts of the British Commonwealth, and there is one each from Brazil, the Dominican Republic, Surinam and the United States. In the notes on activities of the staff it is noteworthy that the Principal recently travelled in West Africa to discuss there with educational authorities the arrangements for African students to take courses at the College.

Four new staff houses were scheduled for completion by the end of 1949, and the construction of the new biology building is in progress. Reference is made to the reports of the Governing Body and of the Principal, which deal in particular with progress made in the four research schemes (banana, cocoa, soils and sugar) and with the development of the new College farm. It is stated that, owing to difficulties of production, only two six-monthly omnibus numbers of *Tropical Agriculture* appeared in 1949; it is hoped to resume monthly publication this year. Among the staff the following appointments have been made: Mr. P. Holliday (Cambridge), pathologist in cocoa diseases; Miss M. E. M. Price (Toronto), librarian; Mr. E. G. D. Pritchett (Oxford and Toronto), farm manager. The second issue notes the appointment of Sir Raymond Priestley in succession to the late Sir Frank Stockdale as chairman of the Governing Body, and the resignation of Prof. A. de K. Frampton, professor of agriculture, on his appointment as agricultural adviser to the Development and Welfare Organisation in the West Indies. The London office of the College is at 40 Norfolk Street, London, W.C.2.

## Nationalized Audit Service

AT one of its recent sectional meetings the British Institute of Management discussed the need for an independent management audit service for nationalized undertakings, though no final recommendations were agreed by the meeting (B.I.M. Conference Series 11. Pp. 36. London: 17 Hill Street, W.1, 1949. 2*s*. 6*d*.). Mr. F. C. Hooper, in introducing the subject, explained that in essence a management audit is a fault-finding body, since its main job is to find out what is wrong and to set in motion steps to put it right. It cannot, however, be usefully conducted on a nationalized undertaking by an outside group of people; but there should be at least one member of the audit drawn from outside the undertaking who should be of the highest professional and public standing. The remaining members, including the chairman, should be drawn from within the undertaking. The chairman and at least one other member should be top-level executives or members of the board, whichever is appropriate. Mr. Hooper also suggested that it would be a good thing to include workers' representatives, especially in regional audits.

## International Conference at Florence of University Teachers

THE fifth conference of university teachers organised by the International Association of University Professors and Lecturers will be held at the University of Florence during April 12–16, under the chairmanship of Prof. A. Portman, of the University of Basle. The conference will be open to all members of the Association and others interested, and university institutions are invited to send representatives. Definitive reports on the following three topics will be considered: (1) equivalences of university qualifications; (2) arrangements in the universities for periodical long leave; (3) student health services in universities. Progress towards the establishment of an International Institute of the Social Sciences will be reported. The present position of the Association will be reviewed and suggestions considered regarding its immediate future programme. Social gatherings will be arranged, and there will be opportunities of seeing other centres of science and learning, such as a visit to the University of Siena on April 15. Names of those expecting to attend the conference should reach the Secretary at as early a date as possible; the registration fee is 10*s*. Further particulars can be obtained from Mrs. Cecil, Secretary, I.A.U.P.L., 13 Old Square, Lincoln's Inn, London, W.C.2.

## Exhibition in London of French Scientific Instruments

AN exhibition of scientific instruments, similar to the annual one held in Paris by the Société Française de Physique (see *Nature* of December 24, 1949, p. 1077), is shortly to be held at the Science Museum, South Kensington, London, S.W.7. The aim of the exhibition, which was conceived in French scientific circles, will be to demonstrate to the British scientific public the present state of instrument technology in France. The exhibits will represent the work of the Centre National de la Recherche Scientifique, the Office National d'Etudes et de Recherches Aeronautiques, the Commissariat à l'Energie Atomique and a number of scientific instrument manufacturers. While the emphasis will be on instruments for

physical research, other branches of study will be represented, including photography, medical physics, civil and mechanical engineering and chemistry. The exhibition is under the patronage of the Cultural and Commercial Counsellors to the French Embassy. During the course of the exhibition a number of public lectures by French men of science will be given, details of which will be announced shortly. The exhibition will be open to the public without charge during February 9–26 (weekdays, 10 a.m.–6 p.m.; Sundays, 2.30–6 p.m.). A comprehensive catalogue of some 100 pages will be on sale at the Museum, and representatives of the participating bodies will be present throughout to assist visitors with additional technical information.

## Physical Society's Annual Exhibition

THE thirty-fourth annual Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society will be held during March 31–April 5 inclusive at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7. The Exhibition will be open on March 31, April 3 and April 4 from 10 a.m. to 1 p.m. and from 2 p.m. to 9 p.m., and on April 1 and April 5 from 10 a.m. to 1 p.m. and from 2 p.m. to 5 p.m. The morning session on March 31 is for fellows of the Society and the Press only. It will be noted that the Exhibition is to remain open for a longer period than in previous years. Invitations to exhibit have been accepted by firms, research associations, universities and government departments as in the past, and the handbook of the Exhibition containing descriptions of all items to be displayed will be available from the Secretary-Editor, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, at the beginning of March, price 6*s*. post paid. During the Exhibition, discourses will be given by Prof. S. Chapman, Dr. W. D. Wright, Dr. F. J. Scrase and Sir Robert Watson-Watt. The Craftsmanship and Draughtsmanship Competition for Apprentices and Learners is again being held, and some of the entries will be on view at the Exhibition.

## Zoological Society of India: 1949 Elections

FOUNDATION fellows of the Zoological Society of India, who were elected in 1949, are as follows: Dewan Anand Kumar (Solan), Dr. A. A. Ayer (Madras), Dr. K. N. Bahl (Lucknow), Dr. D. V. Bal (Bombay), Dr. J. L. Bhaduri (Calcutta), Dr. D. R. Bhattacharya (Allahabad), Dr. B. S. Bhimachar (Calicut), Dr. B. S. Chanhan (Calcutta), Dr. B. N. Chopra (New Delhi), Dr. B. K. Das (Hyderabad), Mr. M. N. Datta (Calcutta), Prof. R. Gopala Aiyer (Waltair), Dr. S. L. Hora (Calcutta), Dr. M. O. T. Iyengar (Calcutta), Dr. T. S. Job (Barrackpore), Dr. G. L. Kestiven (Singapore), Dr. K. B. Lal (Kaupur), Dr. M. S. Mani (Agra), Prof. H. R. Mehra (Allahabad), Prof. M. B. Mirza (Aligarh), Prof. A. B. Misra (Benares), Dr. K. S. Misra (Calcutta), Prof. M. A. Moghe (Nagpur), Dr. K. B. Nair (Trivandrum), Dr. N. K. Panikkar (Mandapani), Dr. H. S. Pruthi (New Delhi), Dr. L. S. Ramaswami (Bangalore), Dr. H. S. Rao (Mandapani), Dr. H. N. Ray (Mukteswar), Dr. M. L. Roonwall (Dehra Dun), Prof. B. R. Seshachar (Bangalore), Prof. R. V. Seshaiya (Annamalainagar), Dr. S. B. Setna (Bombay), Lieut.-Colonel R. B. Seymour Sewell (Cambridge), Miss N. G. Sproston (Shanghai), Dr. B. Sundara Raj (Lucknow), Dr. Viswanath (Hoshiarpur), Dr. G. S. Thapar (Lucknow), and Dr. A. Wolsky (Delhi).

## University of Adelaide

AN announcement has been made inviting applications for twenty-eight new teaching posts, including chairs of philosophy, mathematics and physics, at the University of Adelaide. The size and resources of this University, which has always played a leading part in Australian science and thought and has produced an unusual number of persons now outstanding in British scholarship, have already expanded considerably since the end of the War. The further development which is now projected is the result of the decision of the Government of South Australia to make a substantial increase in its University vote, following representations by the vice-chancellor, Mr. A. P. Rowe, who was appointed in 1947. It is intended that the new appointments (for which applications close in London with the Association of Universities of the British Commonwealth on January 31) should make possible not only the extension into new fields of the University's teaching and research activities, but also a liberal provision of overseas study-leave for all members of the staff and a reversion to pre-war conditions in the matter of reasonable freedom from teaching duties for research.

## University of London: Appointments

THE following appointments in the University of London have been announced: Dr. E. H. F. Baldwin, to the University chair of biochemistry tenable at University College from January 1; Prof. H. E. M. Barlow, professor of electrical engineering at University College, to the Pender chair of electrical engineering tenable at the College from October 1, 1950, in succession to Prof. R. O. Kapp, who will be retiring at the end of the session 1949–50. The title of professor of chemistry in the University has been conferred on Dr. Kathleen Lonsdale in respect of the post held by her at University College; and the title of professor of aeronautical engineering in the University on Dr. N. A. V. Piercy, in respect of the post held by him at Queen Mary College.

## Announcements

THE University of Leeds has recently received an anonymous gift of £40,000 towards the cost of the rayon technology building, and also the following grants: £5,000 to Prof. W. T. Astbury from the Nuffield Foundation for fundamental investigations on rheumatoid arthritis; £2,000, spread over two years, to the Department of Biomolecular Structure from the International Wool Secretariat; and £1,432 from the Royal Society for research in the Physics Department.

IN the article on "Acoustics of Rooms" in *Nature* of December 24, p. 1080, reference is made to various bodies having contributed towards the cost of Dr. R. H. Bolt's visit to Britain to give the lectures which the article describes. Mr. Joseph Emberton, chartered architect, points out that he is not connected with Electrical Musical Instruments, Ltd., and made a gift purely on his own account.

FURTHER details in connexion with the second Oil Shale and Cannel Coal Conference of the Institute of Petroleum have recently been announced (see *Nature*, August 6, 1949, p. 216). The dates of the Conference are July 4–6, and it will take place at the Royal Technical College, Glasgow. The Conference will open with the James Young Centenary Lecture, and this will be given by Prof. W. M. Cumming. Further details can be obtained from the Secretary of the Institute of Petroleum, 26 Portland Place, London, W.1.

# THE PYKNO-X-RAY METHOD FOR DETERMINING ATOMIC MASSES

By Prof. T. BATUECAS

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In view of the precision reached in the determination of crystal densities and X-ray data for solids, it is now possible to determine atomic masses with accuracy. This new method, which C. A. Hutchison and H. L. Johnston[1] applied for the first time to lithium fluoride, to deduce the atomic mass of fluorine, is based on the comparison of the solid to be studied with calcite, of which the density, grating space and geometrical structural constant are all known with great precision. Recently I suggested[2] that calcite may not be the best reference substance, and that perhaps it would be better to take for this purpose sodium chloride. But whatever substance is selected as standard, it is desirable that the densities and X-ray data, both of the substance chosen and the standard, should be compared at the same temperature. Unless this is done, corrections involving coefficients of thermal expansion are necessary which involve uncertainties of varying importance in the results. However, in my opinion these uncertainties can be reduced to a minimum and even cancelled out by simplifying the method in the way described below.

Nevertheless, before explaining with concrete examples how the atomic masses are worked out by means of the new pykno-X-ray method, I think it necessary to point out that the Avogadro number $N_A$ adopted is not the value calculated by R. T. Birge as the most probable value, namely, $N_A = (6{\cdot}0233_8 \pm 0{\cdot}0004_3) \times 10^{23}$ mol.$^{-1}$, but $N_A = (6{\cdot}0231 \pm 0{\cdot}0004) \times 10^{23}$ mol.$^{-1}$ (rounded off to three places of decimals), deduced by the same author[3] from very accurate measurements at 20° C., carried out with several samples of calcite in which the slight impurities were taken into account. Obviously the value we adopt for $N_A$ corresponds to only one substance, calcite, whereas the more probable value represents the weighted mean of five independent values; but as in the pykno-X-ray method it is necessary to have a reference substance, and as this obviously cannot be oxygen, calcite is the best choice for the Avogadro number.

In support of this view I give below an account of the results deduced for the atomic masses of carbon, sodium, potassium, fluorine, silicon, arsenic and lead, taking the values that in my opinion must be considered as the best ones for diamond, sodium chloride, potassium chloride, lithium fluoride, silica ($SiO_2$), arsenic trioxide ($As_4O_6$) and galena (PbS). The calculations have been carried out taking into account that the molecular mass of a crystal depends on: (*a*) the volume of its unit cell; (*b*) the number of molecules contained in the latter; (*c*) its density ($\rho$); and (*d*) the Avogadro number $N_A$. Since these values are known—at a given temperature—for each substance, a simple formula enables the atomic mass to be calculated. Finally, in the formulæ I propose, the crystal density and the grating space must be expressed in the absolute system.

*Diamond.* With the density at 23·5° C. determined by J. A. Bearden[4], using the 'free submerged float' method, $\rho^{23{\cdot}5} = (3{\cdot}51536 \pm 0{\cdot}00004)$ gm./cm.$^3$, and the coefficient of cubic expansion, $\alpha = 3{\cdot}54 \times 10^{-6}$, we deduce: $\rho^{20} = 3{\cdot}51540$ gm./cm.$^3$. For the grating space we take the value given by Y. Tu[5]: $d^{20} = 3{\cdot}55966$ A., or $d'^{20} = 3{\cdot}56688 \times 10^{-8}$ cm., because in multiplying by 1·00203 we transform to absolute the values based on Siegbahn's scale. As in the diamond the unit cell contains eight atoms of carbon, the formulæ to be employed are: $8M_{diam.} = N_A \cdot \rho_{diam.} d'^3_{diam.}$, and substituting values I deduce for the atomic mass of carbon,

$$C = 12{\cdot}010_8.$$

*Sodium chloride.* Using the 'temperature of flotation' method, H. L. Johnston and C. A. Hutchison[6] found for the density at 27·634° C. of very pure sodium chloride: $\rho^{27{\cdot}634} = (2{\cdot}16165 \pm 0{\cdot}00002)$ gm./ml. As the coefficient of thermal expansion is: $\alpha = 1{\cdot}21 \times 10^{-4}$, I deduce: $\rho^{18} = 2{\cdot}16418$ gm./ml., or $\rho^{18} = 2{\cdot}16412$ gm./cm.$^3$. Taking as grating space the value given by Y. Tu[5]: $d^{18} = 5{\cdot}62836$ A., or $d'^{18} = 5{\cdot}63978 \times 10^{-8}$ cm., the formula $4.M_{NaCl} = N_A \cdot \rho_{NaCl} \cdot d'^3_{NaCl}$ gives: $M_{NaCl} = 58{\cdot}456$. Finally, adopting Cl = 35·457, we deduce for the atomic mass of sodium,

$$Na = 22{\cdot}999.$$

*Potassium chloride.* By the 'crystal suspension' method, C. A. Hutchison[7] gave for the density at 28·098° C. of very pure potassium chloride: $\rho^{28{\cdot}098} = (1{\cdot}98651 \pm 0{\cdot}00002)$ gm./ml. Using as coefficient of thermal expansion[6] the value: $\alpha = 1{\cdot}13 \times 10^{-4}$, we have $\rho^{18} = 1{\cdot}98877$ gm./ml. or $\rho^{18} = 1{\cdot}98872$ gm./cm.$^3$. Taking for grating space the value[8] $d^{18} = 6{\cdot}27816$ A. or $d'^{18} = 6{\cdot}29090 \times 10^{-8}$ cm., and substituting these values in the formula $4.M_{KCl} = N_A \cdot \rho_{KCl} \cdot d'^3_{KCl}$ we have: $M_{KCl} = 74{\cdot}554$, and subtracting Cl = 35·457, we deduce for the atomic mass of potassium,

$$K = 39{\cdot}097.$$

*Lithium fluoride.* Taking for density at 27·67° C. the value given by C. A. Hutchison and H. L. Johnston[1]: $\rho^{27{\cdot}67} = (2{\cdot}63835 \pm 0{\cdot}0001)$ gm./ml., and as coefficient of thermal expansion[10] $\alpha = 1{\cdot}00 \times 10^{-4}$, the density of lithium fluoride at 20° C. will be $\rho^{20} = 2{\cdot}64037$ gm./ml., or $\rho^{20} = 2{\cdot}64030$ gm./cm.$^3$. For the grating space of lithium fluoride, Straumanis, Ievins and Karlsons[11] gave $d^{20} = 4{\cdot}01739$ A. or $d'^{20} = 4{\cdot}02555 \times 10^{-8}$ cm. Using the formula $4M_{LiF} = N_A \cdot \rho_{LiF} \cdot d'^3_{LiF}$, and substituting the various numerical values, we have: $M_{LiF} = 25{\cdot}935_2$; finally subtracting Li = $6{\cdot}939_6$, we find for the atomic mass of fluorine,

$$F = 18{\cdot}996.$$

*Silica (α-quartz).* The pyknometric measurements at 0° C. carried out by C. Gutierrez Losa in this Laboratory, using my precision technique[12] with very pure transparent quartz, give for the density of $SiO_2$, $\rho^0 = (2{\cdot}6508 \pm 0{\cdot}00008)$ gm./ml., or $\rho^0 = 2{\cdot}6507_4$ gm./cm.$^3$. Taking as coefficient of cubic expansion the value $\alpha = 3{\cdot}529 \times 10^{-5}$, the density at 18° C. will be $\rho^{18} = 2{\cdot}64913$ gm./cm.$^3$. The grating space given by A. H. Jay[14] at 18° C. is $a = 4{\cdot}9029$ A. or $a' = 4{\cdot}91285 \times 10^{-8}$ cm., and $c = 5{\cdot}3933$ A. or $c' = 5{\cdot}40425 \times 10^{-8}$ cm.; from the equation: $6.M_{SiO_2} = 3.N_A \cdot \rho_{SiO_2} \cdot a'^2 \cdot c'$, and substituting the various numerical values, we find $M_{SiO_2} = 60{\cdot}081$. Therefore the atomic mass of silicon is:

$$Si = 28{\cdot}081.$$

This value is close to that found by several authors (Si = 28·087)[15] with the mass-spectrograph, but

higher than the one accepted by the International Commission, namely, Si = 28·06.

*Arsenic trioxide (octahedric).* By the pyknometric method, C. Gutierrez Losa has found for the density at 0° C. of a very pure sample of $As_4O_6$ the value $\rho^0 = (3{\cdot}8776 \pm 0{\cdot}0002)$ gm./cm.³. Taking as coefficient of cubic expansion[16], between 0 and 25° C., $\alpha = 9{\cdot}3 \times 10^{-5}$, the density at 23° C. will be $\rho^{23} = 3{\cdot}8694$ gm./cm.³. The grating space of octahedric $As_4O_6$ has been measured with great accuracy by Straumanis and Ievins[17], who found at 23° C. $d^{23} = 11{\cdot}0521$ A. or $d'^{23} = 11{\cdot}0745 \times 10^{-8}$ cm. Using the formula $8.M_{As_4O_6} = N_A.\rho_{As_4O_6}.d'^3_{As_4O_6}$, and substituting the numerical values, gives $M_{As_4O_6} = 395{\cdot}68_6$, and for the atomic mass of arsenic,

$$As = 74{\cdot}92_9.$$

*Galena (PbS).* The measurements at 0° C. carried out by C. Gutierrez Losa with galena from Puertollano (Ciudad Real, Spain), carefully selected so as to remove all the quartz, gave for the density of lead sulphide $\rho^0 = (7{\cdot}6068 \pm 0{\cdot}0004)$ gm./cm.³. Taking for coefficient of cubic expansion[18] $\alpha = 6{\cdot}04 \times 10^{-6}$, the density of galena at 18° C. will be $\rho^{18} = 7{\cdot}5985$ gm./cm.³. The grating space of very pure galena has been measured by E. von Zeipel[19] at 18° C.: $d^{18} = 5{\cdot}9232_4$ A. or $d'^{18} = 5{\cdot}92526 \times 10^{-8}$ cm. Using the formula $4.M_{PbS} = N_A.\rho_{PbS}.d'^3_{PbS}$, and substituting the several numerical values, we find, $M_{PbS} = 239{\cdot}22_8$; hence, subtracting S = 32·066, the result for the atomic mass of lead is,

$$Pb = 207{\cdot}16.$$

From the various results obtained for the atomic masses studied, we conclude that the pykno-X-ray method for determining atomic masses is very satisfactory. On the other hand, the method would be much more accurate if the crystal densities and grating space measurements had been measured *at the same temperature* and, if possible, *with the same sample.* Accordingly, all future work on this subject in this Laboratory will be carried out on this basis.

Finally, it would be better to take as reference standard instead of calcite another substance such as diamond. Then, of course, the value used for the Avogadro number would be that deduced from diamond. Calcite has been adopted here because in our opinion its density, grating space and structural geometrical constant have been determined with greater accuracy than any other crystalline solid.


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# PREFERENTIAL RELEASE OF ASPARTIC ACID DURING THE HYDROLYSIS OF PROTEINS


By Dr. S. M. PARTRIDGE and H. F. DAVIS

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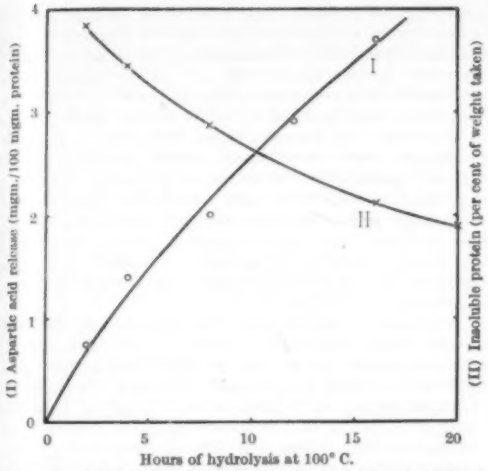
DURING a study of the progress of hydrolysis of ovomucin and ovomucoid, it was observed that aspartic acid was preferentially released from the protein moiety of these mucoids on partial hydrolysis with acetic acid or oxalic acid at 100° C. The effect was not confined to the mucoids and has since been observed with proteins of several other classes, including egg albumin, edestin, insulin and gelatin. In a typical experiment, weighed samples of protein were heated for varying periods of time with 0·25 *M* aqueous oxalic acid in sealed glass tubes at 100° C. Oxalic acid was removed by neutralization to *p*H 4 with barium hydroxide, and the large protein fragments remaining were precipitated by the addition of three volumes of ethanol. The supernatant 75 per cent alcoholic solution, containing the smaller protein fragments and any free amino-acids liberated during the course of the hydrolysis, was evaporated to dryness under reduced pressure. The solid residue was made up with a known volume of water and used for qualitative and approximate quantitative analysis by filter paper chromatography. The accompanying table illustrates qualitatively the release of aspartic acid, glutamic acid and other amino-acids from various proteins, and it is to be noted that, in all cases except those of ovomucin and gelatin, aspartic acid was the only amino-acid to be released in substantial quantity during the first eight hours of hydrolysis.

RELEASE OF ASPARTIC ACID, GLUTAMIC ACID AND OTHER AMINO-ACIDS FROM VARIOUS PROTEINS ON HYDROLYSIS WITH 0·25 *M* OXALIC ACID

| | | Hours hydrolysis | | | |
|---|---|---|---|---|---|
| | | 2 | 4 | 8 | 16 |
| Insulin | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | | (+−) |
| | other amino-acids | | | | (+−) |
| Edestin | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | (+−) | + |
| | other amino-acids | | | | + |
| Egg albumin | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | (+−) | + |
| | other amino-acids | | | (+−) | + |
| Gelatin | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | + | ++ |
| | other amino-acids | | (+−) | ++ | ++++ |
| Ovomucoid | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | | + |
| | other amino-acids | | | | |
| Ovomucin | aspartic acid | + | ++ | +++ | ++++ |
| | glutamic acid | | | + | ++ |
| | other amino-acids | | (+−) | ++ | ++++ |

Key: (+−), trace; +, weak spot; ++, fairly strong spot; +++, strong; ++++, very strong.

The graph shows the release of aspartic acid from recrystallized ovalbumin on hydrolysis with 0·25 *M* oxalic acid at 100° C. No other amino-acids were detected after the first eight hours hydrolysis; but at sixteen hours weak spots due to glutamic acid and other amino-acids appeared on the paper chromatograms. The graph also shows the amount of protein precipitable by 75 per cent ethanol at various times during the course of the hydrolysis, and it is clear from inspection of the curves that release of aspartic




(I) Release of aspartic acid; (II) protein remaining insoluble in 75 per cent ethanol

acid is accompanied by a closely corresponding reduction in the amount of material remaining as particles of high molecular weight.

If we consider the hydrolysis of a peptide chain by means of a weak organic acid, the $p$K of the acid does not greatly differ from the $p$K of any free carboxyl groups that may be present in the chain. These groups are thus partly undissociated and may serve as a local source of hydrogen ions capable of effecting the hydrolysis of adjacent peptide bonds, but inactive against other peptide bonds situated at greater distances. Aspartic acid and glutamic acid residues in proteins are frequently in the amide form, and thus the free —COOH group is masked; but since the acid hydrolysis of such amides is rapid[1,2], the release of free carboxyl groups should occur early in the hydrolysis. Once released, the side-chain carboxyl of aspartic or glutamic acid is free to act as a proton donor and to promote the hydrolysis of the peptide links involving α-carboxyl. If this occurs, release of the α-amino-group should proceed rapidly, since there are then available two free carboxylic acid groups capable of promoting the hydrolysis.

The same kind of argument applies to the free carboxyl at the end of the peptide chain, and if the argument is valid, hydrolysis of a peptide not containing dicarboxylic amino-acids should proceed by stepwise removal of the terminal member of the chain. Partial hydrolysis should thus result in the production of free amino-acids together with a peptide residue of reduced chain-length. This is in sharp distinction to the effect of hydrolysis with strong mineral acids at low temperatures, where the resulting product is mainly dipeptide in character[3], and there is evidence that the peptide linkages involving the amino-groups of serine and threonine are the least stable[4]. On hydrolysis with weak organic acids, release of the dicarboxylic amino-acids would be expected to be particularly rapid where these occur as terminal members of the chain or where they occur in sequences occupying adjacent positions with respect to one another.

The accompanying table shows that glutamic acid is in each case one of the first amino-acids, after aspartic acid, to be released in substantial quantity. The release of aspartic acid at an earlier stage than glutamic acid is to be expected, since the values of $pK_1$ and $pK_2$ are both considerably lower in the case of the former.

It is noteworthy that di- and tri-peptides were not found in the early stages of the hydrolysis, and also that the neutral amino-acids appear before the bases. This was demonstrated by the following experiment. A sample of ovalbumin was hydrolysed by means of 0·25 $M$ oxalic acid for sixteen hours, and the fraction soluble in 75 per cent ethanol was concentrated and used for the preparation of two-dimensional chromatograms. The results showed the presence of a high concentration of aspartic acid and, in addition, weaker spots due to glutamic acid, serine, glycine, threonine, alanine, valine and leucine appeared on the chromatograms. Spots due to the basic amino-acids were not observed, and small peptides giving the ninhydrin reaction also seemed to be absent. However, a fairly large part of the hydrolysis product was in the form of large polypeptides which gave no colour with ninhydrin. This material was demonstrated by eluting (with water) a cut portion of the paper chromatogram. After hydrolysis with 5·5 $N$ hydrochloric acid, the eluted material was found to contain all the amino-acids originally present in the protein but was low in aspartic acid content. The free amino-acids released by partial hydrolysis with oxalic acid may be residues occupying the terminal positions in the various chains initially present in the protein, together with the terminal members of the various chain fragments produced by early rupture.

It may be appropriate to remark here that the conversion of collagen to gelatin is not accompanied by the liberation of aspartic acid, although the amino-acid is released on further degradation of the gelatin. In an experiment to test this point, a sample of finely powdered collagen prepared from bovine tendon was heated with 0·1 $M$ oxalic acid at 80° C. In two hours conversion to gelatin was complete, but the 75 per cent alcohol-soluble fraction showed only a trace of aspartic acid.

The preferential release of aspartic acid on hydrolysis with weak organic acids is of particular interest since it may offer a means of breaking a protein molecule at specific points in the peptide chain. From our results it appears that three main fractions are obtained from partial hydrolysis with organic acids: (*a*) protein fragments of colloidal size; (*b*) polypeptides of high molecular weight which give no colour with ninhydrin; (*c*) aspartic acid, together with much smaller quantities of other amino-acids. Fraction (*a*) is suitable for further fractionation by electrophoresis, and in an exploratory experiment it was found that fraction (*a*) from partially hydrolysed insulin gave several well-defined peaks in the electrophoresis apparatus of Tiselius. However, the most interesting results are likely to be obtained from the analysis of fraction (*b*); but this must await the development of fractionation procedures suitable for large polypeptides of this kind. An attempt is now being made to apply these findings to a study of the mucoids and proteins of white of egg.

The work described in this communication was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research.

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# MECHANISM OF ELECTRO-POLISHING

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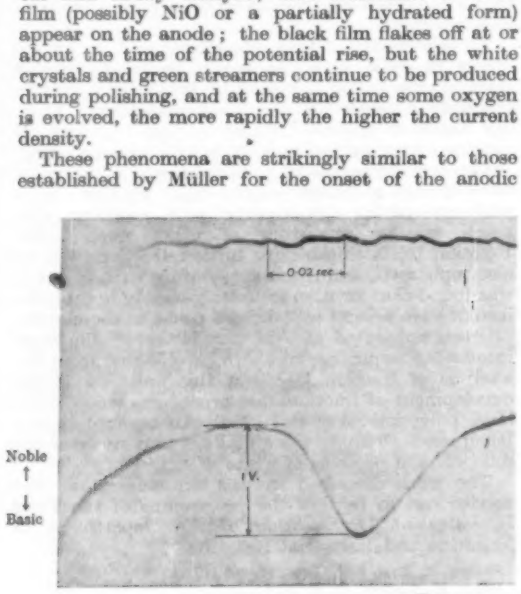
THE production of a specularly reflecting surface by anodic attack on an initially rough metal involves: (*a*) the selective removal of metal from the asperities rather than the depressions, and (*b*) the avoidance of the formation of etch figures on the smoothed surface. Many authors have laid emphasis on the first phenomenon, and it has been explained rather vaguely as a consequence of the formation of a layer of high electrical resistance in the liquor next to the dissolving metal; the second phenomenon, although of equal importance, has been relatively ignored.

Studies in the electropolishing of nickel, to be reported in detail elsewhere, have led us to formulate the following hypothesis for its mechanism, which we believe may prove to have general application.

When nickel is made anodic in, for example, a 50/50 sulphuric acid/water bath (with or without glycerine additions), electropolishing occurs if the current density is high enough[1]. Ordinary anodic dissolution to an etched surface, however, occurs at first, and a time interval is required (shorter the higher the current density) before polishing conditions are set up; there is a small slow rise of anodic single potential during this time interval and a large rapid one at its end, whereupon polishing begins. During the time interval, streamers of green $Ni^{++}_{aq.}$ flow from the anode, and accompanying this production of dissolved nickel, powdery, nearly white crystals of $NiSO_4$ (anhydrous) and $NiSO_4.H_2O$ (shown by chemical and X-ray analysis) and sometimes a black film (possibly NiO or a partially hydrated form) appear on the anode; the black film flakes off at or about the time of the potential rise, but the white crystals and green streamers continue to be produced during polishing, and at the same time some oxygen is evolved, the more rapidly the higher the current density.

These phenomena are strikingly similar to those established by Müller for the onset of the anodic passivity of nickel[2], iron and other metals in less concentrated sulphuric acid. Müller suggested that the initial production of a relatively loose layer of solid corrosion products, formed by precipitation from saturated solution, leads after a time interval to a very high current density locally at the base of pores in the layer. This produces passivity, with evolution of oxygen and cessation of metal dissolution, the original loose layer of corrosion products becoming dissipated. Müller at first attributed passivity to an interior change in the metal, but later, after Evans had isolated very thin compact oxide films from anodically passivated metal[3], adopted the now accepted theory that it is caused by the formation of a compact oxide film.




Oscillation of anode potential at lowest current density giving polishing. Upper trace, time; lower trace, electropolishing oscillations

We believe that the rapid rise of potential observed at the onset of electropolishing is also due to the similar formation of a compact oxide film on the metal surface, but that the crucial difference between the electropolishing and passive conditions is that the compact film is readily dissolved by the more concentrated acid necessary for electropolishing, dissolving, indeed, as fast as it is formed and, in the case of nickel, never reaching a thickness of more than a few unit cells. Such a film would allow the observed discharge of oxygen at its surface (such discharge at a bare metal surface, without oxide formation, is inconceivable), but would be undetectable either by film-stripping or by electron diffraction. It would also, if very thin, allow easy transport of nickel ions through it by lattice diffusion; and their continual removal as aquo-ions from its outer surface would allow the process of polish attack to continue.

Moreover, the conception of nickel metal 'dissolving' into a solid oxide lattice, not immediately to aquo-ions, explains why etch figures on the metal surface are not formed. For etching, it is necessary that selective removal of atoms from certain lattice portions occur, so that definite lattice planes are formed as surfaces of the etch figures. This is to be expected when normal dissolution to dissolved aquo-ions proceeds, since the energy-hump for the dissolution process will be least for particular lattice positions. But when the actual anodic process is the transfer of the metal atom from the metal lattice into a lattice-defective solid oxide film, it is the random distribution of lattice vacancies in the oxide film next to the metal that will decide which metal atoms can at any instant undergo the process; a metal atom in the favourable position for dissolution into a liquid medium can scarcely 'dissolve' if there is no adjacent vacant site in the film, and conversely, one in a normally unfavourable position will dissolve relatively easily if there is an adjacent vacant site in the film. Thus the production of a specular surface without etch figures, consequent upon the random anodic removal of metal atoms, is readily explained by the present theory.

When a constant current density only just large enough to produce electropolishing (of nickel in the sulphuric acid bath) is applied, violent oscillations of the potential difference across the bath (that is, of the anode single potential, since the cathode single potential and the electrolytic ohmic drop are constant) are noticed just after the rapid potential rise; this phenomenon has often been observed for many cases of electropolishing, and the rather similar but slower oscillations found in cases of anodic passivity have been studied in detail by Müller[2] and by Hedges[4]. By using a 110-v. direct current source and a large

rheostat in series with the cell, we have been able to adjust the current density to a suitable, almost constant, value (*c.* 0·06 amp./cm.² at 35° C.) at which the potential difference oscillations can be maintained almost indefinitely. Using a high-gain pentode D.C. amplifier and a double-beam cathode-ray oscillograph with a very slow time-base, we have obtained the accompanying record, which shows about one and a half of the oscillations, the magnitude and speed of which are remarkable; the potential difference rises by *c.* 1 v. in *c.* 0·06 sec. and falls again in *c.* 0·02 sec.

The oscillations are readily explained in terms of the present theory as follows. The rise of potential is due to the growth of the very thin passivating oxide film, its rate of anodic formation from the metal being greater than its rate of dissolution; as this forms, oxygen can be discharged at its surface as an alternative anodic reaction, so the current density available for film formation diminishes. The rate of film formation thus becomes less than the (constant) rate of dissolution, and the film disappears, giving a fall of potential to that characteristic of active metal. Oxygen now ceases to be discharged, film-building again takes over, and so the process goes on. Calculation shows that the thickness of film formed before dissolution supervenes can be only of the order of a few unit cells.

We may note that many electropolished metals behave, from a corrosion or tarnishing point of view, as if a very thin compact oxide film is left after polishing; in some cases, for example, aluminium, a relatively thick compact film has been demonstrated microscopically[4]. We believe that the present hypothesis for nickel may be quite general qualitatively, differences in different metals arising from differences in the electrical conductivity and ease of dissolution of the oxides, which would lead to varying thicknesses in the steady-state electropolishing films.

The much-discussed 'smoothing' effect in electropolishing, consequent on the dissolution of asperities, is also readily explained in terms of Müller's theory of anodic passivity. The relatively thick, mobile layer of saturated solution and solids forms before the 'passive' film has been produced, and in electropolishing continues to form (perhaps with modified composition) and to dissipate afterwards. It will clearly be both thicker and less disturbed in the hollows on the surface than on the asperities. Because it is *thicker*, the current density in the hollows will be the less from ordinary considerations of ohmic resistance, which may be expected to be reasonably high for a layer containing much solid. Because it is *less disturbed*, we may expect conditions for passivity to be reached sooner in the hollows than on the asperities, and the consequent great increase in anodic polarization in the hollows will divert most of the current to the asperities. The former reason for smoothing has often been urged; we believe the latter, first clearly stated by Evans[6], may be much the more important.

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[6] Evans, U. R., *Trans. Electrochem. Soc.*, **69**, 653 (1936).

# A CULTURE METHOD FOR GROWING SMALL FREE-LIVING AMŒBÆ FOR THE STUDY OF THEIR NUCLEAR DIVISION

By Dr. B. N. SINGH
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THE genera and species among the small free-living, intestinal and parasitic amœbæ have been largely created by previous workers on the basis of their nuclear structure and their mode of nuclear division. A review of the literature on the nuclear division in small free-living amœbæ clearly shows great confusion in the cytological investigations carried out by the different workers. This has been due to two principal reasons: first, the difficulty of getting the various normal stages of nuclear division on account of the lack of suitable cultural conditions; and secondly, the use of cytological techniques which are not specific for the location of chromatin and non-chromatic materials during all the stages of nuclear division. This has resulted in the creation of a large number of species of small free-living amœbæ, the great majority of which can only be identified by those who described them.

In the past, small free-living amœbæ have usually been grown for the study of their nuclear division in nutrient liquid media with uncontrolled bacterial food supply. Two main methods have been used for making cytological preparations: (1) cover-slips were put at the bottom of the liquid media for amœbæ to grow on them; (2) coverslips were also floated at the top hoping that amœbæ would crawl over them and multiply. After various intervals the cover slips were removed and cytological preparations were made. The suitability of such methods for getting the stages of nuclear division can be judged by the following remark of Dobell[1], who took great pains to study the nuclear division in free-living amœbæ; he says (p. 146): "I may add here that chance plays a large part in determining the success—or the reverse—which rewards the efforts of those who try to study the methods of division in many species of amœbæ".

A method is described below which enables one to get easily all the stages of the nuclear division in small free-living amœbæ. It was first developed by me[2] in connexion with the work on *Leptomyxa reticulata* Goodey and has been found suitable for the study of the nuclear division in large numbers of species of amœbæ isolated from soil and fresh-water during the past four years. It is hoped that the method described here may lead to a more satisfactory way of classifying, at least, the small free-living amœbæ by the study of the nuclear divisions of a large number of species under controlled cultural conditions and with suitable bacterial food supply. Moreover, the method as presented here or in a modified form is applicable to the study of the cytology of other groups of Protozoa and other micro-organisms.

'Pure mixed' cultures starting from single cysts or single trophic forms were obtained on non-nutrient agar (1·5 per cent agar in 0·5 per cent sodium chloride; *p*H 6·6–7·0) plates supplied with a young culture (2–5 days old grown on nutrient agar slopes)

of *Aerobacter* sp.[3], strain 1912, as food supply. This bacterium has been found to be one of the best sources of food for soil amœbæ and other groups of micro-predators during an extensive study of the selection of bacterial food by several groups of soil holozoic organisms during the past ten years. The single cysts or the trophic forms were washed at least six times in 0·5 per cent sodium chloride by transferring them from one washing to the other by separate micropipettes. All precautions were taken to work under sterile conditions. After several sub-cultures, each sub-culturing being done after four to seven days, pure-line cultures were once again started from single cysts. All the species of small amœbæ so far isolated either from soil or from fresh-water have been found to grow exceedingly well on *Aerobacter* sp. Amœbæ that were required for cytological preparations were sub-cultured every 24 or 48 hours, depending on their rate of growth and multiplication, for a few days in order to get healthy, young and actively dividing forms. They were then grown on non-nutrient agar films by the method described below.

Thin films of non-nutrient agar were made on slides as follows: one or two small drops of hot melted agar (1·5–2 per cent depending on the quality of agar) were spread as a thin film by quickly covering with a No. 1 $\frac{3}{4}$-in. or slightly larger coverslip. When the agar had solidified, the coverslip was gently pushed from one side and removed from the slide with the help of a pair of fine forceps, leaving the film on the slide. With some practice it is easy to make a film on a slide within three to five minutes. A thin piece of agar all around the film is then cut off to get rid of the excess agar that had come out of the coverslip. This also helps in removing the whole film under water, at a later stage. Now one or two loopfuls of a thick suspension of a young culture of *Aerobacter* sp. in 0·5 per cent sodium chloride were gently smeared on the agar surface, and mass inoculation of young and actively dividing amœbæ from the agar plate was made on the film. The slides were kept in moist chambers in Petri dishes in order to prevent the drying of the agar films, and were incubated at 20–21° C. Every precaution was taken to prevent the contamination of the film. Usually six to eight film cultures were made from each strain of amœbæ at about 7 p.m. and the films were fixed the next day in suitable fixatives; each film culture was fixed at an interval of an hour, starting from 10 a.m. The slides were put into the fixative with the film surface downwards, and after a minute they were gently turned over. The slides after the fixation for a suitable length of time were put into 90 per cent ethanol for 24 hours, and then they were brought through 70, 50 and 30 per cent ethanol for a few minutes each to distilled water. At this stage the film of agar was removed by giving a gentle shake to the slide. A large percentage of amœbæ usually remain stuck to the slide after the removal of the film. It seems that amœbæ sink through the agar and remain stuck to the glass when the film is removed after fixation. The amœbæ were then stained and permanent preparations were made in the usual way.

By the above method large numbers of normal, young and actively dividing amœbæ ranging from 15 hr. to 23 hr. old can be found on a single slide. As they are confined to a small area on the slide, it is easy to find dividing individuals in all stages under the oil-immersion lens. It must be pointed out that some practice and patience is necessary to use this method successfully.

The nuclear division in twelve strains of amœbæ, consisting of at least nine distinct species, has been studied by the above method. The various stages of nuclear division could be obtained whenever desired. There is no need to rely on chance to get stages of nuclear division, as was the case with the methods used by previous workers. The study of the nuclear cytology in small free-living amœbæ and its bearing on the classification of amœbæ will be published elsewhere. It may be pointed out here that the mode of nuclear division of these amœbæ falls into two main types. There is no such great diversity in the nuclear division among the different species belonging to these groups as one was led to believe, for much of the previous work was often based on too few species or on unsuitable techniques. The study of adequate numbers of dividing cells by the above method, combined with selective staining methods, will doubtless result in a great simplification of the present classification of these forms.

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# GENERATION AND ANALYSIS OF ULTRASONIC NOISE

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A GREAT deal of research work has been carried out in recent years on the physiological effects of audible noise from aero-engines and aircraft in flight. About two years ago, the Acoustics Laboratory of the Department of Otorhinolaryngology, Central Medical Establishment, Royal Air Force, undertook the study of the inaudible component of noise or ultrasonics produced by turbo-jet aircraft in flight and turbo-jet engines on test beds. The project was considered under two headings: (1) analysis of the ultrasonic noise thus produced; (2) generation, in the laboratory, of this ultrasonic noise at high intensity, to determine what physiological effect it has on living organisms.

As no suitable apparatus for carrying out these investigations was available in Great Britain, its design and construction was the first task of the

Fig. 1. Condenser microphone and pre-amplifier

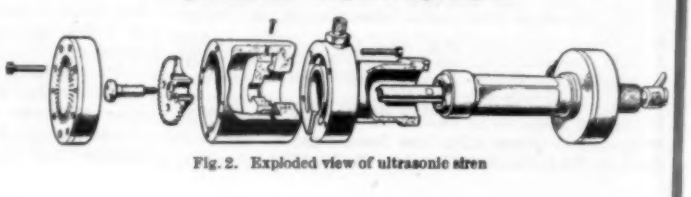

Fig. 2. Exploded view of ultrasonic siren

Laboratory. The major items required were: (*a*) one or two miniature microphones, operating up to a frequency of at least 100 kc./s., and their associated special amplifiers, together with a wave analyser covering the same range; (*b*) a range of Hartmann generators covering the same frequencies to determine the sensitivity of the microphones by comparison with a calibrated standard; (*c*) a siren that would generate the ultrasonic noise at a high intensity for the physiological experiments.

*Ultrasonic Microphones.* Several microphones were designed and produced. The most satisfactory ones were calibrated against the 'Brush *BM*. 101' hydrophone and used in all the experiments. Both piezo-electric and condenser types were tried, and finally one of each was selected. Fig. 1 is a cut-away drawing of the condenser microphone, with its head amplifier and output/supply cable. This instrument possesses a fairly even response up to 100 kc./s., and its polar diagram in the plane of the diaphragm is close enough to a circle for the slight discrepancies, due to the incident sound, to be ignored.

For calibration, the sound pressure at a wide variety of frequencies, produced by a suitable generator operating under fully controlled conditions, was measured by the hydrophone. The hydrophone was replaced in turn by each of the microphones being calibrated. Their output was noted, and thus was established the relationship between incident sound pressure and voltage output throughout the required frequency-range. From the foregoing it can be seen that all measurements of sound (audible or otherwise) were made indirectly.

The Hartmann generators are pure acoustic devices which operate on a principle similar to that of a Galton whistle. Each generator consists of a jet through which compressed air issues into a resonator. The rapid 'filling up' and 'spilling over' of the resonator produces oscillations, at a frequency dependent upon the physical dimensions of the jet and resonator, and to a lesser degree on the distance between them. Thirty-five of these generators were made to cover the frequency-range at intervals of 3 kc./s.: they were assembled on a calibration stand so that they were radially disposed around the microphone at a distance of 100 cm. from it.

*Ultrasonic Siren.* If compressed air is forced through a slot which can be opened and closed at high speeds, puffs of air having a high acoustic-energy content are produced; the frequency of the note thus generated is the number of times per second the slot is opened and closed. This principle is utilized in the ultrasonic siren; it is not, however, a simple matter to open and close a slot at sufficient speed to produce pressure waves at a frequency of the order of 100 kc./s. Accordingly, several slots are arranged circumferentially in the flat end of a totally enclosed cylinder. A toothed disk is rotated behind these slots so that its teeth alternately open and block off the slots; the frequency of the note thus produced is the product of the number of slots and the number of revolutions per second of the toothed disk.

As can be seen from Fig. 2, this is what has been done in the case of the siren designed in this Laboratory. Three stator and rotor sets giving a maximum energy output at 25 kc./s., 50 kc./s. and 100 kc./s. have been made; the rotor in each case is driven by a compressed-air motor which has a maximum speed exceeding 36,000 r.p.m. The volumetric air consumption of the siren is of the order of 100–120 cu.ft. per min. at a pressure of not less than 125 lb./sq. in.

*Analysis of Ultrasonic Component of Noise.* Measurements of the intensity at varying frequency of ultrasonics arising from jet engines on test beds and jet aircraft in flight at a speed not higher than 300 m.p.h. have shown that ultrasonics are present up to a frequency of at least 100 kc./s. The intensities so far measured, however, are not of such magnitude as to cause any harm to ground personnel or aircrew. It is anticipated that with airspeeds approaching the speed of sound, the ultrasonic 'noise' intensities may be high. The major part of the ultrasonic 'noise' produced under these conditions of flight is aerodynamic in origin.

Thanks are due to the Director-General of Medical Services, Royal Air Force, for permission to publish this article.

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# GERMAN HYDROGRAPHIC INSTITUTE, HAMBURG

## ANNUAL REPORT

THE German Hydrographic Institute in Hamburg (which, since the constitution of the German Federal Republic, comes no longer under the Bizonal Administration but under the Federal Government) has recently issued its report* on the third year (1948) of its activity. This runs to sixty-six pages of text, eight charts, one page of sketches and seven illustrations. In addition to a report on general changes and events in the section for organisation, this volume contains *inter alia* details of "Sailing Directions", lists of lights, and lists of radio signals as well as of charts. An account is given of the wreck-locating operations and of the areas in the German Bight surveyed by the sounding boats of the Institute.

In the year under report, the Institute joined with the fishery biologists in making investigations in the field of oceanography, and, in respect of coastal waters, it resumed work directed to the protection of the coast in co-operation with the appropriate institutions. Its Geomagnetic Service has worked up and issued the magnetic observations for the year 1943 made by the Institute's Geomagnetic Observatory at Wingst. Tide tables and nautical year-books are, it is understood, issued by its Department of Tides once a year. In 1948, twenty-two ice reports were issued, and thirty-two storm tide warnings relating to thirty days were promulgated. The Department of Nautical Engineering continued to improve nautical instruments (magnetic and gyro compasses among them) and, in addition, checked a great number of nautical instruments for shipping interests.

The progress attained in re-establishing the exchange of publications with foreign countries is very naturally referred to with satisfaction. A comprehensive index, showing the official publications of the German Hydrographic Institute as well as the work of the scientific staff, is given as an appendix. The index and the index charts giving information about German "Sailing Directions" and charts which have been published, put in hand, or decided upon, replace the "List of Books and Charts" previously issued by the former German Navy. Though the German Hydrographic Institute was not able to open any more agencies in 1948, it has increased the number of official sale agencies which it keeps supplied with charts and navigation books.

* Annual Report No. 3, 1948. German Hydrographic Institute. (Authorized by the Allied Control Council for Germany.) Pp. 66. (Hamburg, 1949.)

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Development of the Universe

THE theories of Mr. F. Hoyle and Prof. Pascual Jordan have renewed an interest in an important cosmological problem: How and when did the substance of the material universe come into existence? It may facilitate discussion if the difficulties in the way of the various theories about this are summarized in the simplest possible terms.

The difficulty in the theory that all the matter in the universe has existed for an infinite time is that it would then have reached certain limiting conditions, limits, for example, of concentration; of entropy; of radius of curvature of an expanding universe. Mathematical analysis has shown that no such limits have been reached.

The difficulty in the assumption that all the matter in the universe has existed for a finite time is of a different kind. The assumption depends on the hypothesis that two moments in time have had a peculiar significance. One is the moment when matter first began to appear, the other the moment when the process of appearance stopped. This assumption is further based on the hypothesis that, while holding rigidly now in such a way as to cause the total energy in the universe to be constant, the principle of conservation of energy did not hold in the same way during the period between the two above-mentioned hypothetical moments of time.

One of several difficulties in Prof. Jordan's theory is the underlying hypothesis that $10^{80}$ protons can have a real existence for a definite period of time before, in the form of a star, they emit a signal by which they could be detected. Mr. Hoyle's theory, though it has the advantage of simplicity, raises one grave difficulty. If interstellar space had been witnessing the appearance of matter for an infinitely long time, an infinite amount of it would have followed a gravitational field in the direction of such large accumulations as the nebulæ. So these would have reached infinite size.

This latter difficulty would be overcome if one assumes that the continuous appearance of matter is accompanied by its continuous disappearance; though both processes need not be at the same rate. If so, the present increase in the total contents of the universe postulated both by Hoyle and Jordan is a differential effect. This assumption contains, I think, a minimum of hypothesis. It does not postulate the simultaneous appearance of any specific or even large numbers of protons, and allows for the possibility that single small particles may appear at any given time or place. It does not postulate that any given region in space is more privileged than any other to be the site of the appearance of a new particle, and it does not postulate that any existing particle is more privileged than any other to disappear at a given moment.

The automatic results of such completely random appearance and disappearance would be that most new matter would come into existence in interstellar space, while most disappearances would occur in concentrations such as the nebulæ. Thus these would be continuously renewed and roughly compensated for the matter that has fallen, as it were, through them out of existence.

If matter is both appearing and disappearing at all times completely at random, the second Law of Thermodynamics will not lead to an infinite increase in entropy, for the increase will be counteracted by the potential energy of new matter in interstellar space. The net increase need not always be positive. It could sometimes be negative and cause a reversal of the present expansion of the universe. While this was happening, the total mass of nebulæ as well as individual stars would tend to diminish, and it should be possible to show that there is a maximum concentration above which disappearances are more rapid than appearances, so that concentrations of matter can only vary between specific limits.

Lastly, there appears to be some misapprehension concerning the bearing of the principle of conservation of energy on cosmological theories. This principle states that in a self-contained system the total amount of energy is constant. If matter may appear or disappear at random, the conclusion is that, in practice, one cannot be sure of ever having a self-contained system, not that the principle does not hold.

REGINALD O. KAPP

University College,
London, W.C.1. Oct. 21.

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IN the system of cosmology I have advocated, and also in the parallel theory of Bondi and Gold, the nebulæ are not all of infinite age as Prof. R. O. Kapp seems to imagine. In a sufficiently large volume $V$ cm.$^3$ of space, the number of nebulæ with ages greater than $T$ ($T$ being measured in units of Hubble's constant, namely, $1{\cdot}8 \times 10^9$ years) is about $10^{-72}\ V\ e^{-3T}$, the average spacing between nebulæ older than $T$ being about $10^{24}\ e^T$ cm. By taking $V$ large enough, it is true that a nebula of arbitrarily large $T$ can be found. But this has little interest when related to astronomical observation, for the effect of the red shift of light, arising from the expansion of the universe, is to make the observation of events occurring at distances greater than about $1{\cdot}7 \times 10^{27}$ cm. inherently impossible (even for an observer equipped with a perfect telescope). It follows, therefore, that the oldest nebulæ within the observable portion of the universe have ages $T$ given, so far as order of magnitude is concerned, by

$$10^{24} \exp T = 1{\cdot}7 \times 10^{27},$$

that is, $T = 7{\cdot}44$ Hubble units $= 1{\cdot}34 \times 10^{10}$ years. These nebulæ have been identified tentatively with the nebulæ in the great clusters. It may be noted in passing that a specially chosen observer can detect *one* condensation having an age $T$ appreciably greater than the value given by the above equation. But the probability of this occurring for an observer taken at random decreases with increasing $T$ according to the factor $\exp - 3T$.

The above remarks summarize results which show that, although condensations of increasing age and size can occur, their distances from the observer increase correspondingly. This has the effect of making very old nebulæ optically unobservable, and also of making negligible their influence on the metric in the portion of the universe accessible to the observer.

It appears, therefore, that Prof. Kapp's objection concerns a question that has no relation to observation. A similar remark applies to an issue raised by Prof. Jordan in *Nature* of October 15, 1949, p. 637. He points out that my work leads to the conclusion that there must be an inter-nebular medium in which

the material density is about a hundred times greater than the smoothed-out average density of the nebulæ themselves. He goes on to dismiss this requirement on the grounds that it finds no favour with observational astronomers. Now I stated explicitly that on my theory the inter-nebular medium consists effectively of hydrogen, which has negligible scattering effect on the light received from even the most distant nebulæ observed. Moreover, a uniform inter-nebular medium has no effect on the peculiar motions of the nebulæ. Thus there is no way in which such a medium can be directly observed, and, accordingly, one is left wondering under what canon of logic Prof. Jordan refers the issue to observational astronomy for a decision.

I also find it difficult to understand why Prof. Born raised the question of the conservation of energy, for one of the most striking results of my work, and also of the work of Bondi and Gold, is that the large-scale features of the universe are independent of time. The conservation of energy is a trivial consequence of this result.

It remains to consider objections to the suggestions made by Prof. Jordan and Prof. Kapp. If the matter of the universe originates in large explosive lumps, identified by Prof. Jordan as supernovæ, it is difficult to understand why the diffused matter is observed to be concentrated in nebulæ instead of being more or less uniformly distributed, and also why the supernovæ are apparently confined to the nebulæ instead of being uniformly distributed throughout space. There is also the serious difficulty that the observed rate of supply of material by the novæ and supernovæ is far too small to be cosmologically significant, amounting as it does to only about one-thousandth of the masses of the nebulæ in a time equal to one Hubble unit ($1{\cdot}8 \times 10^9$ years). Also the material emitted from supernovæ almost certainly has a very different chemical composition from the material comprising the nebulæ (which are largely composed of hydrogen). The temperatures and densities in supernovæ are so high that nuclear reactions take place very rapidly, and it is to be expected that their effect is to leave the material far poorer in hydrogen content than normal interstellar material.

Turning now to Prof. Kapp's interesting suggestion, if the disappearance of matter in dense condensations were at all comparable with the required rate of appearance of matter in inter-nebular space (this rate being fixed so as to get the observed rate of expansion of the universe), then, as can be shown, every dense body, such as a planet or a star, must lose half its mass in less than $10^9$ years. A rapid decrease of mass of this order can scarcely be reconciled with astronomical and geophysical data.

F. Hoyle

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Cambridge.

## A High-Efficiency Neutron Detector

The recent development of scintillation counters as high-efficiency detectors of gamma-radiation makes attractive the possibility of detecting neutrons by means of the γ-rays produced in many neutron-induced reactions. Particularly interesting is the detection of the 480-keV. γ-ray given off by the excited lithium-7 in the reaction:

$$B^{10} + n \rightarrow Li^{7*} + He^4$$
$$Li^{7*} \rightarrow Li^7 + \gamma\ (480\ keV.).$$

Ninety-three per cent[1] of the intermediate boron-11 nuclei decay via this excited state of lithium-7. We have detected the γ-rays from this reaction and also from the $(n,\gamma)$ reactions in cadmium, indium and samarium.

The Harwell crystal spectrometer was used for providing a source of mono-energetic neutrons with a comparatively low proportion of accompanying γ-rays. The sample was placed in the beam of neutrons diffracted from a calcium fluoride crystal. The scintillations produced by the resultant γ-rays in an anthracene crystal were detected by an R.C.A. 931A. photo-multiplier tube. The counter was protected from the intense background of neutrons and γ-rays from the pile by successive shields of lead, cadmium and paraffin wax.

The efficiency of the counter remained constant with all samples, except the indium, for neutrons with energies lying between 0·04 and 0·2 eV. The indium sample was the only one which was not 'black' over this range. The detection efficiency for boron was approximately 1 per cent, and for the other samples about 4 per cent. The comparatively low efficiency of boron is largely due to the fact that only one γ-ray is produced for every neutron captured, while several γ-rays are given off in the $(n,\gamma)$ reactions in cadmium, indium and samarium. However, in the energy region above a few hundred electron volts, where this detector is likely to be of most value, the boron cross-section is well known.

The scintillation detector described above should provide a counter which is more efficient than a boron trifluoride counter for neutrons with energies lying between 100 and 100,000 eV. A practicable thickness of boron-10 (2–2½ cm.) is effectively 'black' to neutrons of up to 10,000 eV., so that the efficiency should remain constant up to this energy. It will best be employed with sources relatively free from γ-rays, such as the pulsed time-of-flight spectrometer suggested by Cockcroft[2]. Work on these applications is proceeding.

We wish to thank Mr. G. N. Harding for supplying us with an anthracene crystal.

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Aug. 22.

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[2] *Nature*, **163**, 869 (1949)

## Photo-electric Disintegration of the Deuteron at 6·13 and 17·6 MeV.

We have measured the cross-section of the deuteron for disintegration by γ-rays of effective energy 6·13 and 17·6 MeV. The results are:

$$\sigma_{6\cdot13} = (21{\cdot}5 \pm 1{\cdot}2) \times 10^{-28}\ \text{cm.}^2$$
$$\sigma_{17\cdot6} = (\ 8{\cdot}5 \pm 1{\cdot}2) \times 10^{-28}\ \text{cm.}^2$$

(both these uncertainties are probable errors). The γ-rays were obtained, in the first case, by bombarding thick targets of calcium fluoride with protons of energy 890 keV., and, in the second, by bombarding thick targets of lithium hydroxide with protons of energy 500 keV. The disintegrations were produced in an ionization chamber of volume 475 c.c. containing deuterium at a pressure of 38 atmospheres; the

pulses from the resulting protons were analysed by a ninety-nine channel kick sorter. An identical chamber, filled with ordinary hydrogen, was used for estimating the various background effects. The γ-ray flux from the fluorine target was measured by counting the α-particles emitted prior to the de-excitation of the residual oxygen-16 nucleus. The flux of higher energy γ-rays was measured with a thick-walled graphite ionization chamber: confidence in the computations was increased by the agreement (within 3 per cent) between the values of the 6·13-MeV. γ-ray flux deduced by this method, and by the more certain α-particle counting method. In the reduction of the results, allowance has been made for the small and known inhomogeneity of the γ-rays in both cases. The energies of the γ-rays have been adopted from the work of Walker and McDaniel[1], and their relative intensities from this work and from that of Burcham and Freeman[2]. For the purpose of these slight corrections, the form of the dependence of cross-section on γ-ray energy given by the 'old' theory[3] has been assumed.

Previous measurements of this cross-section have been reported, at the lower energy by van Allen and Smith[4], who find $(11{\cdot}6 \pm 1{\cdot}5) \times 10^{-28}$ cm.², and at the higher energy by Wäffler and Younis[5], who find $(8 \pm 3) \times 10^{-28}$ cm.².

The theory of the photo-disintegration of the deuteron is not sufficiently definite at the moment to enable a comparison with these experiments to be made in a short note.

We would like to thank Dr. W. B. Lewis for arranging for the analysis of the deuterium at the laboratories of the National Research Council of Canada at Chalk River.

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Dec. 14.

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## Sub-Crystals in Aluminium Observed with Polarized Light

In the course of some work on crystal-grain phenomena in creep specimens of aluminium alloys, we have used the polarized light technique for microscopic examination described by Hone and Pearson[1], and found clear evidence of the original crystals breaking down into sub-crystals under certain conditions of deformation. In this technique, any grain contrast seen is due to differential orientation in the aluminium, at least with unstrained metal.

Before creep tests were undertaken, material in course of preparation was examined, and distinct differences between hot- and cold-rolled metal were found. The microstructure of hot-rolled material is shown in Fig. 1; the original large grains still exist as regions between which there are large orientation differences; but they have broken down into much smaller sub-crystals between which there are usually relatively small contrast differences, suggesting relatively small orientation differences. The original grains have acquired an irregular outline which corresponds to the sub-crystal structure. The

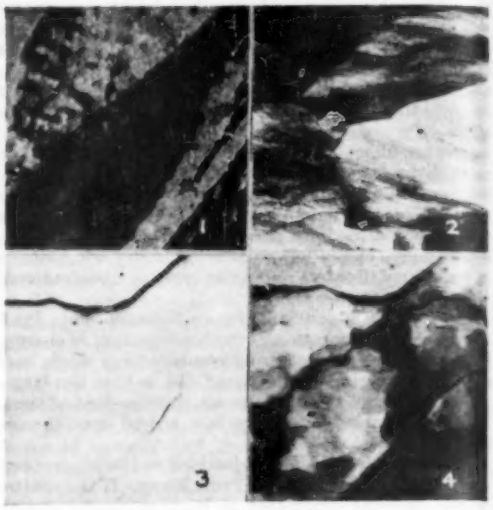


Fig. 1. Hot-rolled; polarized light
Fig. 2. Cold-rolled; polarized light
Fig. 3. Creep specimen; normal lighting
Fig. 4. Same area as Fig. 3; polarized light
All photographs × 200

structure of cold-rolled material is shown in Fig. 2 and has neither an irregular grain outline nor a clear sub-crystal structure. If the patchiness inside the large grains truly indicates orientation differences in this strained material, the change in orientation between patches occurs gradually over a considerable distance, and not sharply as in the sub-crystal structure of Fig. 1.

At this juncture the paper by Wilms and Wood[2] was received describing the observation of a 'cellular' appearance on the polished surface of a creep test specimen during test. This structure was not observed in specimens deformed at room temperature, so it seemed very probable that the 'cells' and the sub-crystals referred to above were identical.

It was therefore with added interest that examination of the creep specimens was commenced. A transverse section of a specimen strained 20 per cent in 20 hr. at 200° C. is shown under normal illumination in Fig. 3 and under polarized light in Fig. 4. The sub-crystal structure is actually well developed, although practically invisible under normal illumination.

These results thus support the observations of Wilms and Wood, and show that the sub-crystal structure develops not only at the surface but also throughout the body of the material during suitable hot deformation. The sub-crystal structure may be similar to that which has been observed in certain rather special samples of cold-worked and annealed aluminium[3].

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## Influence of the Bonding Electrons on the Scattering of X-Rays by Carbon

DURING the course of an investigation of the scattering of X-rays by various carbons (incompletely graphitized materials containing graphite-like layer-planes but no three-dimensional crystalline order, and showing, therefore, only (00*l*) crystalline reflexions and (*hk*) two-dimensional bands) it was observed that the intensity of the (10) band was always anomalously high. The phenomenon was found to be of perfectly general occurrence for a wide variety of carbons. For microcrystalline graphite a similar anomaly was observed in the intensity of the (100) line. Moreover, examination of intensity curves published by other authors[1] confirms the generality of the phenomenon.

Details of these results, which were obtained with a high degree of accuracy, are being published in *Acta Crystallographica*. A vacuum camera and strictly monochromatic radiation were used. Measurements were made for values of $\sin\theta/\lambda$ up to 1·1, and, after correction for absorption and geometric factors, the intensity of scattering at large angles was used for obtaining the complete scattering curve in absolute (electron) units. Using the equations developed by Warren[2], which give both the form and the absolute intensity of the (*hk*) bands in terms of a single variable, the layer diameter, it was found that the observed intensity of the (10) band was twice the theoretical intensity. For the (11) and all higher-order bands the observed and calculated intensities were in good agreement.

This anomaly is clearly not one which can be explained by the influence of thermal agitation. If the observed 50 per cent reduction in the ratio of the intensity of the (11) band to that of the (10) were due to thermal agitation, then the intensity of the higher-order bands would be reduced in even greater proportion, whereas, in fact, all higher-order bands show, within experimental error, the theoretical intensities. Moreover, as has been mentioned above, measurements of *absolute* intensities show that it is the (10) band which is enhanced, and not the other bands which are reduced in intensity.

These results indicate that the influence of thermal agitation on the intensity of the (*hk*) bands is negligible. This is perhaps not surprising. The (*hk*) bands are due exclusively to the structure within a single graphite-like layer, and the thermal vibrations in the plane of such a layer must be considerably less even than in diamond. Indeed, Nelson and Riley[3] have shown that graphite has virtually no thermal expansion in directions lying in the plane of the layers.

It seems that the anomalously high intensity of the (10) band (or of the (100) line) must be attributed to the configuration of the valency electrons in graphite or in carbons containing incipient graphitic layers. The atomic scattering factors used for calculating intensities were those of James and Brindley[4]. These apply to a spherical, non-bonded atom, and are therefore particularly liable to error for light atoms in which the proportion of electrons involved in bond-formation is high. The error is greatest at low angles where the contribution of the outer, bonding electrons to the total scattering is large. In carbon, the only (10) band (or (100) reflexion) which occurs in the angular range in which the *L*-electrons make an appreciable contribution to the atomic scattering factor is the (10) (or (100)), and it is here that an anomaly may be expected.

The three $sp^2$ electrons in a graphitic carbon atom are directed in a single plane, the layer-plane, and are concentrated around the centres of the C—C bond rather than at the atomic nuclei[5]. The following qualitative calculation shows that this configuration may be expected to lead to a (10) band or (100) reflexion of intensity greater than that calculated for a spherical atom.

For a spherical atom, the electron density in a spherical shell of radius $r$ and thickness $dr$ is uniform and equal to $\rho(r)$. The contribution of this shell to the amplitude of the (100) line or to that of the (10) band in the position corresponding to the (100) line is given, for a unit cell containing two atoms in a single graphitic layer, by

$$dF'_{10} = 4\pi r^2\rho(r)dr\,\frac{\sin(2\pi r/d_{100})}{2\pi r/d_{100}} = dm\,\frac{\sin(2\pi r/d_{100})}{2\pi r/d_{100}}$$

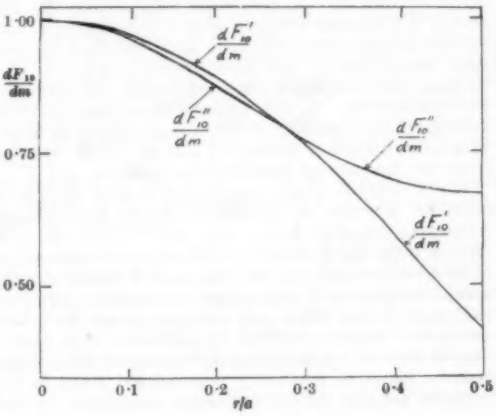
in electron units, where $dm = 4\pi r^2\rho(r)dr$ and $d_{100}$ is the spacing for the (100) reflexion in graphite.

If it be supposed, as a very rough approximation for the $sp^2$ electrons, that the electron content of each such shell is equally distributed between three points still at distance $r$ from the atomic nucleus, but situated on the C—C bonds in the graphitic layer, then the contribution to the structure factor for a unit cell containing two atoms becomes

$$dF''_{10} = \frac{2dm}{3}\cos\left\{2\pi\left(\frac{1}{3}+\frac{r}{d_{100}}\right)\right\} + \frac{4dm}{3}\cos\left\{2\pi\left(\frac{1}{3}+\frac{r}{2d_{100}}\right)\right\}.$$

The variation of $\frac{dF'_{10}}{dm}$ and $\frac{dF''_{10}}{dm}$ with $r/a$, where $a = \frac{2}{3}d_{100}$ is the C—C bond-length, is shown in the accompanying graph. It is seen that for small values of $r/a$, $dF'_{10}$ and $dF''_{10}$ differ little; but for values of $r$ approaching half the bond-length, $dF''_{10}$ is considerably greater than $dF'_{10}$. Since the greatest electron density for the $sp^2$ electrons lies midway between two carbon atoms, it is to be expected that the integrated amplitude for the (100) reflexion (or the (10) band) will be greater than that calculated using the atomic scattering factor of James and Brindley.

These results are not in disagreement with measurements by Lipson and Stokes[6] of intensities on a powder photograph of graphite. These authors plot



their results in the form of $I_{obs.}/I_{calc.}$ on a logarithmic scale against $\sin^2\theta$, and show that they are grouped around a straight line the slope of which is considered to represent the temperature factor. The experimental points, however, fall clearly into two groups. In the low-angle part, the ratio decreases approximately according to the logarithmic relationship indicated. But for $\sin^2\theta > 0{\cdot}4$ the ratio is approximately constant. In view of what has been said above, the following interpretation seems more reasonable. The temperature factor is negligible. In the high-angle region only $K$-electrons contribute to the scattering, and the observed and calculated intensities are in constant ratio. In the low-angle part, the ratio $I_{obs.}/I_{calc.}$ for the series (10$l$) decreases with increasing $l$, corresponding to a decreasing contribution of the $L$-electrons with increasing angle of scattering.

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[1] Biscoe, J., and Warren, B. E., *J. App. Phys.*, **13**, 364 (1942).
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## X-Ray Irradiation of Cellulose Acetate

As is well known, the physical properties of many plastics are modified when they are exposed to light or ultra-violet radiation; the most important change is a decrease in tensile strength[1], and an increased electrical conductivity.

In the course of work on these phenomena, samples of undyed, unoiled cellulose acetate yarn were suspended in front of a 0·001 in. aluminium window of a 'Raymax' copper-target X-ray tube, operated at 50 kVp., 30 m.amp., and were exposed to the radiation for periods up to 190 hours.

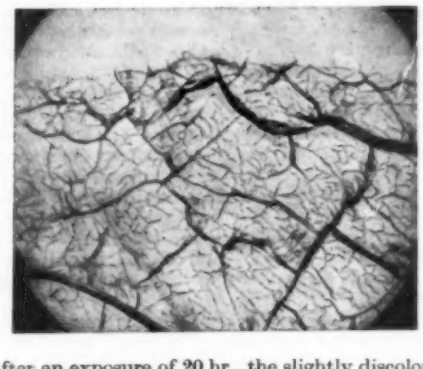
The variation of the breaking load (tensile strength) with exposure was found to be given by:

$$\ln \frac{S_0}{S_T} = kT,$$

where $S_0$ is the original strength, $S_T$ the strength after an exposure of $T$ hours and $k$ is a constant. The tensile strength, measured at 65 per cent relative humidity and 20° C., decreased to less than 50 per cent of the original strength after 120 hours exposure. Similar results were obtained with cellulose acetate yarn containing 3 per cent titanium dioxide delustrant. All breakages occurred within the limits of the irradiated patch, and under a microscope showed a very brittle fracture. Strengths measured at intervals over a further period of 100 hr. after removal from the beam were found to be constant.

X-ray diffraction photographs, of a clear sample of cellulose acetate of relatively high crystallinity, measuring roughly 5 cm. × 4 cm. × 0·15 cm. (cut from a small block obtained by very slow evaporation of an acetone solution), were taken after irradiating the sample by placing it over a circular aperture of 0·5 cm. radius in a lead plate and exposing it to the above radiation for time intervals up to 40 hr. Such photographs showed a progressive diffuseness of the pattern from a series of relatively well-defined rings in the original sample (before exposure treatment) to two very blurred broad rings, similar to the type of pattern obtained from less crystalline samples produced by rapid evaporation of an acetone solution.

At the end of a 40-hr. exposure, the irradiated patch showed a marked yellowish-brown coloration and a mosaic of minute fissures, some of which penetrated the sample, but the majority of which were restricted to the surface of the sample facing the tube, indicating the effect to be due to a long-wave component of the X-ray spectrum. No differential staining was observed with 'Shirlastain'; but on washing out the stain a very large number of new and finer fissures could be seen under the microscope. Both types of fissures are shown in the accompanying photomicrograph, which also shows the clear line of demarcation between the exposed and lead-shielded regions.



After an exposure of 20 hr., the slightly discoloured patch in a sample of unplasticized cellulose acetate film was rapidly delustred in a 1·4 per cent solution of phenol in water, while the shielded regions remained clear even on standing in the solution for 24 hr. In terms of A. R. Urquhart and J. B. Marsden's[2] work on phenol delustring, this effect suggests that X-ray irradiation decreases the crystallinity of the sample, confirming the results of the diffraction patterns discussed above.

When a strip of clear unplasticized cellulose acetate film was dipped into molten paraffin wax so as to be covered by a layer of wax, and then irradiated for 24 hr., bubbles of gas were observed in the wax; these bubbles forced the wax away from the film over the irradiated patch. No gas bubbles were observed on irradiating a control sample of wax for 72 hr., and the gas was therefore presumably given off by the cellulose acetate on irradiation by X-rays.

Certain dyestuffs were found to be bleached when irradiated by the above X-radiation in exposures as short as 9 hr.

The results described seem to indicate that chemical and structural changes may take place in certain substances during long exposures required for X-ray diffraction patterns, and may influence the interpretation of the diagrams.

I am indebted to Mr. S. Simmens for taking the photomicrograph, and to the directors of Lansil, Ltd., for permission to publish this note.

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Research Laboratory, Lansil, Ltd.,
Lancaster. July 14.

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## Influence of Firing Temperatures on the Preparation of Barium Titanate

In the course of work on the preparation of barium titanate ceramics, it was found necessary to determine the extent of the reaction of the starting materials at various temperatures and the crystal structure of the final product.

The barium titanate was prepared by two different methods. In one case, titanium oxide ($TiO_2$) was added to molten $Ba(OH)_2.8H_2O$ at about 100° C.; the other involved mixing and pressing barium carbonate and titanium oxide together. Samples prepared by both methods were heated to various temperatures and then examined by X-ray diffraction methods. The extent of reaction in the formation of barium titanate is indicated in Tables 1 and 2.

Table 1

Samples made from $Ba(OH)_2.8H_2O + TiO_2$

| Temp. of firing (in ° C.) | Percentage of $BaTiO_3$ present |
|---|---|
| 400 | 90 |
| 500 | 50–60 |
| 600 | " |
| 700 | " |
| 800 | " |
| 900 | " |
| 1,000 | " |

Table 2

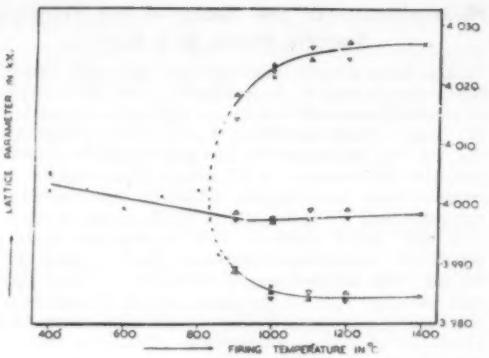
Samples made from $BaCO_3 + TiO_2$

| Temp. of firing (in ° C.) | Percentage of $BaTiO_3$ present |
|---|---|
| 800 | 60 |
| 900 | 80 |
| 1,000 | 90 |
| 1,100 | 95 |
| 1,200 | 100 |
| 1,300 | 100 |
| 1,400 | 100 |

It will readily be seen in Table 1 that, whereas at 400° C. the reaction was at least 90 per cent complete, this was not so when the material was fired at higher temperatures. Barium hydroxide, $Ba(OH)_2$, melts at a temperature somewhat less than 400° C., and this may be the cause of the increased reactivity. Hedvall and his co-workers have studied intensively the effects in reacting systems when one member undergoes a physical change, and it seems that the effect here observed is another example of such an occurrence.

It will be noted that in the first set of experiments, for samples heated to temperatures higher than 400° C., there was no increase in the degree of reaction with temperature up to the limit of 1,000° C., and the total quantity which reacted was actually less at 1,000° C. than at 400° C. Presumably, the material did not exist long in the vicinity of the melting point of barium hydroxide when fired to higher temperatures, and therefore was less influenced by the favourable conditions experienced there. For the samples of barium carbonate and titanium oxide heated over the same temperature-range, there was an increase in the reaction which may be explained by the fact that the barium carbonate is more easily decomposed than the hydroxide. It required a firing of at least 1,200° C. for 1 hour in oxygen for complete interaction of the components, and even then the structure of the resulting compound was not identical with that fired at 1,400° C.

The structure of these materials is most interesting. It is recognized that owing to incomplete reaction in most instances, and the uncertainty in determining the exact quantity of the components which did not react, the resulting compounds may depart from the stoichiometric proportions to some extent. Nevertheless, some general conclusions can be drawn which are of importance. The barium titanate has, for samples heated below 800° C., a cubic lattice of the perovskite type. Above 800° C. it is tetragonal, the axial ratio, lattice parameters, and volume depending on the temperature of firing.




Dependence of lattice parameter on firing temperature

The accompanying graph indicates the results obtained. The volume of the unit cell decreased with temperature until the tetragonal distortion set in. No anomaly in the constants was observable at 400° C. nor was one to be expected in spite of the increase in the extent of the reaction at this temperature. Points were not plotted below this temperature owing to the low accuracy of measurement due to poor crystallization. The lines in the X-ray diffraction pattern are diffuse, the broadening depending on the firing temperature.

The lower density of the product in the cubic region may be due to imperfections in the lattice due to cation and anion sites being randomly vacant. These would decrease the binding energy and also act as a barrier to co-operative phenomena. Now it is well recognized that the electrostrictive properties of barium titanate and the formation of electric domains must involve a co-operative interaction of one unit cell with its neighbour, leading to a polarization in the same sense over the whole of a domain. If imperfections are introduced which hinder this mechanism, the structure may have locally a tetragonal symmetry which may not extend for more than a few unit cells; long-range order is absent, however, and the unique axis is directed in three mutually perpendicular directions in the crystal, the statistical effect of which is to impart a cubic symmetry to the whole. The broadening of the X-ray lines will qualitatively fit in with this view, for as the lines become sharper the density increases until the tetragonal distortion takes place. A sample having a cubic structure was cooled to liquid air temperature to see if the Curie point had been depressed by the preparative conditions; but no change in symmetry was found.

We wish to thank Mr. J. A. M. van Moll and the directors of Philips Electrical, Ltd., for permission to publish this note.

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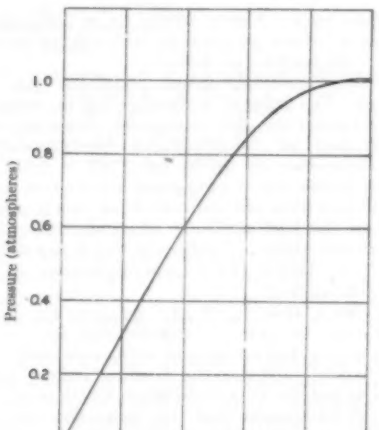
## Measurement of the Ratio of the Principal Specific Heats of a Gas

THE constant, $\gamma$, relating the principal specific heats of a gas may be determined directly by a number of classical methods involving adiabatic expansions, the most reliable of which are the determination of the velocity of sound in the gas (Kundt's method) and the observation of adiabatic variations in gas pressure and temperature (Clément and Desormes, Lummer and Pringsheim's methods respectively).

A new direct method, utilizing another kind of adiabatic change, has been developed to measure $\gamma$ for air. The method can be extended to other gases and involves the observation, on a U-manometer containing mercury, of the growth of pressure with time (see graph) in an initially evacuated chamber into which atmospheric air is effusing through an orifice.




The linear portion of the curve represents the initial stage of the effusion, in which the gas expands laterally after passage through the orifice. The non-linear portion of the curve represents the final stage of the effusion, in which the gas issues in the form of a non-expanding jet, the pressure at the throat of which equals the pressure within the chamber. In accordance with classical hydrodynamics, the pressure, $p$, at which lateral expansion ceases for a perfect gas is given by the relationship: $p = \left(\frac{2}{\gamma+1}\right)^{(\gamma/\gamma-1)} P$, where $P$ is the pressure outside the chamber. The continuity of the pressure–time relationship prevents the accurate determination of $p$ from the diagram. If, however, advantage is taken of the audible introduction of turbulence at the transition point, as has been observed when suitable apertures are used, it is possible to measure $p$ and hence $\gamma$.

The effect has been investigated for circular apertures only, and has been found to be critical when these have finite lengths of the order of their diameters. To minimize errors in the reading of $p$ on the rising mercury column, it has been found necessary to use tubes of diameter not greater than 1 mm. in conjunction with a chamber of volume 50 litres. With the present apparatus, $\gamma$ for air can be estimated to within one per cent of the accepted value.

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July 27.

## A New Naturally Occurring Amino-Acid

INVESTIGATION of the amino-acids of *C. diphtheriæ* by paper chromatography has shown that an acid hydrolysate of the water-insoluble portion of the micro-organism contains an unknown ninhydrin-reacting substance in addition to seventeen known amino-acids[1]. This substance, the position of which on the phenol-collidine chromatogram is shown in Fig. 1, has now been isolated and identified as α - ε - diaminopimelic acid,

$$COOH.CH(NH_2).(CH_2)_3CH(NH_2).COOH.$$

The following method was used for separating the amino-acid from other constituents of the acid hydrolysate. Neutralized hydrolysate was run through a column of acid-treated alumina[2]; the unknown amino-acid, although neutral, was retained on the column with the acidic amino-acids if a sufficient excess of alumina was used, whereas the rest of the amino-acids, with the exception of traces of glycine, serine, threonine and alanine, passed through. Elution with dilute ammonia was followed by electrodialysis of the concentrated eluate. The neutral fraction, completely freed from acidic constituents, yielded on concentration a white crystalline material which proved to be the unknown amino-acid. Each stage in the purification was checked by paper chromatography.

The final product (Fig. 2), after crystallization twice from water and once from aqueous alcohol, gave the following analytical figures: C, 44·3; H, 7·45; N, 14·8; α-amino N (Van Slyke ninhydrin-$CO_2$), 14·4; diaminopimelic acid, $C_7H_{14}N_2O_4$, requires C, 44·2; H, 7·42; N, 14·8 per cent). The crystals were only moderately soluble in cold water and aqueous alcohol, soluble in dilute acids and alkalis, and insoluble in all other solvents. The substance did not melt or decompose up to 305° C.

α-ε-Diaminopimelic acid was synthesized by Sörensen in 1908[3], and the properties as described

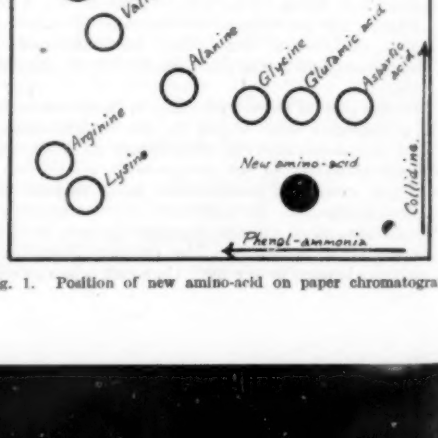


Fig. 1. Position of new amino-acid on paper chromatogram

Fig. 2. Crystals of new amino-acid from *C. diphtheriæ* (× 380)

by him corresponded closely with those of the compound isolated here. Sörensen prepared a dibenzoyl derivative, a specimen of which I have been able to examine through the kindness of Prof. Linderstrøm-Lang. The solubilities of synthetic dibenzoyl-diaminopimelic acid were similar to those of the benzoyl derivative prepared from the new amino-acid, and both crude derivatives melted over the range 181–199° when observed on the micro-stage melting-point apparatus. Repeated crystallization of the dibenzoyl derivative of the naturally occurring amino-acid, first from 25 per cent ethanol and then from ethylacetate light petroleum mixture, produced a compound crystallizing as fine needles of melting point 193° (found: C, 63·7; H, 5·88; N, 6·89; dibenzoyl-diaminopimelic acid, $C_{21}H_{22}N_2O_6$, requires C, 63·3; H, 5·57; N, 7·04 per cent). After similar recrystallizations of the synthetic compound, the resulting crystals did not appear homogeneous under the microscope and melted less sharply at 195–197°; mixed melting point with natural derivative, 193–195°. The crystalline forms of the synthetic and natural dibenzoyl derivatives were not identical. α-ε-Diaminopimelic acid has two optically active carbon atoms, and it is evident that mixtures of stereoisomers could be influencing the solubility, melting point and crystalline form of the benzoyl derivatives of both the natural and the synthetic amino-acids. The optical activity of the naturally occurring amino-acid has not yet been measured, as the possibility of some racemization during preparation was not excluded.

Final proof of structure was obtained by treatment of the amino-acid wth nitrosyl bromide, followed by catalytic reduction of the dibromo derivative; the product was identified as pimelic acid by the fact that it did not depress the melting point of an authentic specimen of pimelic acid. α-ε-Diaminopimelic acid, obtained by hydrolysis of the synthetic dibenzoyl derivative, was indistinguishable from the natural amino-acid on phenol-collidine paper chromatograms.

The new amino-acid occurs mainly in the water-insoluble portion of the diphtheria bacillus, although a small amount is also found, with the other commonly occurring amino-acids, in ethanolic extracts of the cells[1]. It is probable, therefore, that diaminopimelic acid is a constituent of the bacterial protein; its concentration is of the same order as that of the other common amino-acids.

Diaminopimelic acid may well prove to be widely distributed among bacteria, since a substance with similar properties has already been shown by other ...ers[4,5] to be present in certain products of bacterial origin.

I am indebted to Mr. J. Smiles, of the National Institute for Medical Research, for the photograph of the crystalline material.

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## Zirconium Esters

THE interesting results recorded recently by Speer[1], and by Cullinane and Chard[2], on the conditions for the preparation of titanium *ortho*-esters prompt us to mention our experience in preparing *ortho*-esters of zirconium. The literature contains little information on this subject. Meerwein and Bersin[3] have recorded that zirconium ethoxide can be prepared by the following reactions:

(1) $ZrCl_4 + 5\,NaOEt + EtOH = NaH[Zr(OEt)_6] + 4\,NaCl.$

(2) $NaH[Zr(OEt)_6] + HCl = Zr(OEt)_4 + NaCl + 2\,EtOH.$

We find, however, that a number of alkyl *ortho*-esters of zirconium can be obtained directly from the reaction of zirconium tetrachloride, a primary alcohol and anhydrous ammonia. With secondary alcohols this procedure is not satisfactory. The products are hydrolysed esters. The pure esters can be obtained by ester interchange between the ethyl *ortho*-ester and a secondary alcohol. For example:

(3) $Zr(OEt)_4 + 4\,iso\text{-}C_3H_7OH = Zr(OC_3H_7\text{-}iso)_4 + 4\,EtOH.$

In the case of *iso*propyl alcohol, the ester separates as a crystalline solid with the composition $Zr(OC_3H_7\text{-}iso)_4$, *iso* $C_3H_7OH$. The direct action of zirconium tetrachloride and *iso*propyl alcohol yields a hydrolysed chloro-*iso*propoxy zirconium compound. The hydrolysis arises from the water produced by the reaction (4*b*) of the alcohol with hydrogen chloride liberated in the initial reaction (4*a*).

(4*a*) $ZrCl_4 + iso\text{-}C_3H_7OH = ZrCl_3(OC_3H_7\text{-}iso) + HCl.$

(4*b*) $HCl + iso\text{-}C_3H_7OH = iso\text{-}C_3H_7Cl + H_2O.$

The reaction of type 4*b*, involving a secondary or tertiary alcohol and hydrogen chloride, is well known (cf. the reaction of titanium tetrachloride and tertiary butyl alcohol mentioned by Cullinane and Chard[2]).

We have isolated from the reaction of zirconium tetrachloride and ethyl alcohol a new crystalline solid, $ZrCl_3(OEt),EtOH$. This underlines the distinctive difference between the reactions of silicon tetrachloride and alcohols, and the corresponding reactions involving the tetrachlorides of titanium and zirconium. Titanium and zirconium tetrachlorides yield chloro-alkoxy derivatives, whereas the well-known silicon *ortho*-esters are the products from the reactions with silicon tetrachloride. The *ortho*-esters

of zirconium, as one would expect, are much less volatile than those of either titanium or silicon. For example, $Zr(OEt)_4$, crystallized from benzene, sublimes at 120° C. at $10^{-4}$ mm. pressure. The *iso*-propyl ester, with its addendum of *iso*-propyl alcohol, has a melting point of 138–141° C. and the $Zr(OC_3H_7\text{-}iso)_4$ distils at 160° C. at 0·1 mm. pressure.

Details of this work will be published elsewhere.

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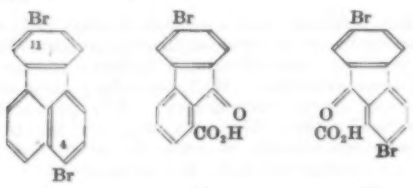
## Orientation of Disubstituted Fluoranthene Derivatives

ALTHOUGH fluoranthene is readily attacked by bromine, etc., none of the disubstituted products has been rigidly orientated. Tobler *et al.*[1] obtained a fluoranthene disulphonic acid, which on fusion with alkali followed by oxidation gave a coloured 'chinhydronartigen' compound, and they rightly pointed out that a quinoid product would mean that sulphonation had occurred at the 4 : 11-positions. Their evidence, however, is not conclusive and experimental details are lacking.




The bromination of fluoranthene yields a substance which we have now shown to be 4 : 11-dibromofluoranthene (I). Oxidation with chromic acid and acetic acid gives a monobromo compound, presumably 6-bromo-1-carboxyfluorenone (II), and 2 : 7-dibromo-1-carboxyfluorenone (III), the constitution of which follows from its decarboxylation products. When heated with quinoline and copper bronze, it yields 2-bromofluorenone, and it is undoubtedly the bromine atom adjacent to the carboxyl group which is removed, since under the same conditions 2-bromo- and 2 : 7-dibromo-fluorenone are unchanged while 2-bromo-1-carboxyfluorenone and 7-bromo-1-carboxyfluorenone yield fluorenone and 2-bromofluorenone respectively. More conclusive proof of the structure of III comes from decarboxylation at 250° with mercuric oxide[2] to give 2 : 7-dibromofluorenone. The constitution of the original dibromofluoranthene is thus unambiguously established, and consequently other disubstituted fluoranthenes can be orientated. For example, the fluoranthene dicarboxylic acid obtained by the action of oxalyl chloride on fluoranthene[3] is the 4 : 11-compound, should it be identical with the di-acid prepared from 4 : 11-dibromofluoranthene by standard methods.

Details of these and related experiments will be published elsewhere.

Thanks are expressed to the Department of Scientific and Industrial Research and to the Anglo-Iranian Oil Co. for grants.

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## Alanine and Taurine Formation from Injected Cysteine in the Rat

THE pathways for cysteine metabolism have been studied intensively, and a great deal is known about the many reactions which lead to the formation of sulphate. Most of the studies on cysteine have been mainly concerned with the fate of sulphur; but relatively few experimental results exist concerning the fate of the carbon chain. Recently, Fromageot and Chatagner[1] have furnished proof of the existence of an enzyme, desulphinicase, in liver of rabbits. This enzyme is capable of liberating sulphurous acid from L-cysteine sulphinic acid. They considered the latter compound to be the most important intermediate in the conversion of organic sulphur to inorganic sulphur; they assumed that the splitting of sulphurous acid from L-cysteine sulphuric acid gave alanine as an intermediate. The formation of alanine from cysteine sulphinic acid has been demonstrated in rabbit liver extracts[2].

Using rats of the Sprague–Dawley strain, it was possible to demonstrate in this laboratory that intravenously administered cysteine causes a significant increase in the concentration of alanine in the liver. The analyses of tissues for alanine were carried out by means of quantitative paper chromatography[3]. In this manner, it was possible to measure simultaneously other amino-acids present in tissues. Taurine, which unfortunately is not well separated from glycine by phenol in one-dimensional chromatograms, was also measured.

CONCENTRATION OF ALANINE AND TAURINE IN RAT LIVER AFTER CYSTEINE INJECTION*

| | Alanine (mgm. per 100 gm. fresh tissue) | | | Taurine (mgm. per 100 gm. fresh tissue) | | |
|---|---|---|---|---|---|---|
| | Time after injection | | | Time after injection | | |
| | 30 min. | 60 min. | 120 min. | 30 min. | 60 min. | 120 min. |
| Controls | 41±1·6 | 44±3·4 | 43±2·3 | 58±2·9 | 60±5·3 | 47±5·3 |
| Cysteine injected | 114±1·9 | 97±4·8 | 71±2·9 | 143±3·2 | 99±3·4 | 99±2·9 |

* Arithmetic mean of values from four animals plus or minus the standard errors corrected for small numbers.

The results shown in the accompanying table were obtained from groups of four animals. The concentration of the alanine and taurine–glycine fractions in the cysteine-injected groups was higher than that found in the saline-injected controls. The differences were statistically significant. This finding warrants

the assumption that taurine and alanine were formed in the cysteine-injected animals.

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## Virulence-enhancing Factor of Hog Gastric Mucin

FROM the time of the original discovery of the virulence-enhancing power for bacteria of hog gastric mucin by Miller[1] and, independently, Nungester[2], the effect has been used extensively in the production of experimental infections of animals, as, for example, in chemotherapeutic and in serum testing (for review, see ref. 3). A large number of different species of bacteria show enhanced virulence when injected intraperitoneally together with the mucin, and the effect is often striking—a reduction of $10^4$–$10^5$ in L.D.50 is frequent. Furthermore, the effect is not confined to hog gastric mucin: other mucins have been reported active. This suggests that the mucins coating epithelial surfaces may aid pathogenic bacteria in their initial attack; such a possibility makes the investigation of mucins for a chemical entity producing the effect an interesting problem.

Several groups have published work along this line. Anderson and Oag[4] using a chemical method, and Gould and King[5] by differential centrifugation, reported the separation of an impure active material from commercial hog gastric mucin. In both cases the fraction was sparingly soluble in water, and of protein rather than carbohydrate nature. King[6] later described a method of extraction with formamide, and stated that his former method was difficult to repeat. Morgan and King[7] prepared blood group A substance from commercial mucin. The preparations retained the virulence-enhancing effect of the original mucin. Electrophoresis of these preparations showed them to contain 90 per cent of a single component and 10 per cent of an ill-defined contaminant.

In commencing work on chemical extraction, the first essential was to develop a statistically adequate method of biological assay. *B. typhosum* (strain $Ty_2$) was selected as the test organism and the mouse as the experimental animal, the test dose being given by the intraperitoneal route. Mucin fractions were compared with a 'standard' mucin preparation, a constant number of organisms being injected in the presence of falling concentrations of the test material. Batches of at least twenty mice were used for any concentration. Using probit analysis, this method of assay would detect regularly rather less than a twofold difference in virulence-enhancing power.

Crude blood-group substance (A and H) was prepared as described before from fresh hog stomach linings[8], instead of from the dried commercial mucin of unknown history. The crude blood-group substance possessed virulence-enhancing activity. By prolonged dialysis at *p*H 4·2 in the refrigerator two fractions were separated. (*a*) A larger soluble fraction (50–60 per cent) which is precipitated by four volumes of alcohol. It contains the blood-group substance (A and H) and, dissolved in water, forms a viscous solution; this has negligible virulence-enhancing activity. (*b*) A smaller insoluble fraction (10–15 per cent) which has virulence-enhancing activity. More of this material was prepared directly from fresh linings, and further purified by extracting with water at *p*H 6 and the use of strong sodium salicylate solutions. This still heterogeneous material was practically insoluble in water at *p*H 7, formed a comparatively non-viscous suspension, and contained 14·5 per cent nitrogen (Dumas). In aqueous suspension alone, different batches had activities from six to nine times greater than the crude blood-group substance. However, when suspended in a completely inactive 3·5 per cent solution of fraction (*a*), which imparts a marked viscosity to the suspension, this activity was increased three-fold. An exactly similar result, namely, a three-fold increase of activity, was produced by suspending the active material in tragacanth mucilage (0·17 per cent w/v, inactive alone) to give a suspension with the same viscosity as the above (Ostwald viscometer, 37°).

Hence the virulence-enhancing power of hog gastric mucin is not due to one factor only, as reported or tacitly assumed in previous work, but to a combination of: (1) the virulence-enhancing factor which is active alone, but far more so in the presence of (2), which is an inert factor or factors which, in view of the experiment with tragacanth, may well act by providing a viscous medium for the virulence-enhancing factor. There is no doubt that blood-group substance (A and H) is responsible for at least part of, if not all, this viscosity.

Full details of this work, which is being continued, will be published elsewhere. Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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## Allergy in Two Stages

THE phenomena very briefly outlined in this communication are the results of a planned series of investigations undertaken to clarify certain observations the significance of which was not at first very evident. Only certain (human) subjects are sensitive to injections of the materials referred to, and it is with regard to such 'sensitives' that the following account applies.

The two preparations used throughout the investigations were selected, (1) from the middle member (later called *B*) of a series of five enzymic protein hydrolysates, representing different stages of a digest ranging from high molecular solutions to relatively low, and (2) from another similarly prepared (later called *A*), this latter representing a relatively low molecular solution, further processed for the removal of the larger molecules. These hydrolysates contained 5 per cent of the original protein and 1 per cent procaine, and were prepared by Messrs. Bengers, Ltd.

Injections were given at three- and four-day intervals (that is, intervals between stages), and a short-size 20 Record needle ensured that they were in part intramuscular and deep subcutaneous. Site of re-injection was always within a few centimetres of the previous site. The sites selected for injection were (1) left upper and outer gluteal quadrant, (2) right upper and outer gluteal quadrant, (3) left deltoid, (4) right deltoid, (5) left fascia lata, (6) right fascia lata.

Reactions following injection, when they did occur, appeared after a ten-minute interval, and the patient was under observation for an average period of two hours.

| Stage | Injection | Site | Reaction | Sites |
|---|---|---|---|---|
| 1 | *A* 5 c.c. | 1 | None perceptible | |
| 2 | *A* 5 c.c. | 2 | None perceptible | |
| 3 | *A* 5 c.c. } | 1 | Erythema induration and urticaria ('triple response') | 1 |
| | *B* 0·4 c.c. } | | | |
| 4 | *B* 0·25 c.c. | 2 | Triple response | 1, 2 |
| 5 | *B* 2 c.c. | 4 | None perceptible | |
| 6 | *A* 1 c.c. | 2 | Triple response | 1, 2 |
| 7 | *A* 0·5 c.c. | 4 | Triple response | 1, 2, 4 |
| 8 | *A* 3 c.c. } | 3 | None perceptible | |
| | *B* 3 c.c. } | 5 | | |
| 9 | *A* 0·25 c.c. | 5 | Triple response | 1, 2, 4, 5 |
| 10 | *B* 0·25 c.c. | 3 | Triple response | 1, 2, 3, 4, 5 |
| 11 | *B* 3 c.c. | 6 | None perceptible | |
| 12 | *A* 0·25 c.c. | 2 | Triple response | 1, 2, 3, 4, 5 |

The following conclusions may be drawn:

(*a*) *A* injected at a free site fails to provoke reaction. *B* injected at a free site is also without reaction. *A* and *B* may be injected simultaneously at separate free sites without provoking reaction.

(*b*) *A* and *B* injected mixed or consecutively at one site even at one-twelfth of the usual dose provokes intense local reaction at that site, and secondarily at all other *AB* sites, but never at an *A* or a *B* site.

(*c*) If *A* is injected at a *B* site or *vice versa*, even though the interval which separates the injections is as long as three months, triple response follows at that site and secondarily at all other *AB* sites. In such an instance *A* and *B* are, as it were, masquerading as allergens.

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## Effect of Streptomycin Preparations on Gut Responses to Contractor Substances

When streptomycin is administered by mouth, only a small proportion is absorbed, and very high concentrations of the drug can be obtained in the stools, 2–9 mgm. per gm. having been recorded without toxic symptoms[1,2]. It seemed of interest, therefore, to determine whether such concentrations could have any effect on the motility of the gut other than by virtue of the bacteriostatic action.

Fresh guinea pig ileum preparations were set up in a standard gut bath of 3·5 ml. capacity, and the streptomycin added either by pipette or by means of a separate alternative reservoir in a system based on that described by Schild[3]. No effect was noted when low concentrations of the drug were employed; but when sufficient streptomycin was added to the bath to produce concentrations of the order of $4{\cdot}8 \times 10^{-3}$ *M*, the normal 'pendulum' movements of the gut were diminished.

To investigate this effect further, known concentrations of acetyl-choline were used to stimulate the gut, and streptomycin was tested as an antagonist. When streptomycin was added to the gut bath to produce a concentration of $1 \times 10^{-3}$ *M*, the contraction caused by acetyl-choline added 30 sec. later was reduced to that produced by 0·7 times that quantity of acetyl-choline in the absence of streptomycin. A similar effect was observed when the streptomycin was added only a few seconds before the acetyl-choline, as well as when both were added together as a pre-mixed solution.

To determine the degree of specificity of this action, a comparison was made substituting histamine acid phosphate for acetyl-choline. In this case, the antagonistic action was greater. The addition to the bath of 0·1 ml. of a streptomycin solution containing 100 mgm./ml., producing a concentration of $4{\cdot}8 \times 10^{-3}$ *M*, completely inhibited the response of the gut to 1 microgram of histamine acid phosphate in 1 ml. of solution added 30 sec. later. If 2 micrograms of histamine acid phosphate were added, it was necessary to double the concentration of streptomycin in order again to produce complete elimination of response. The same direct correlation of streptomycin concentration to histamine acid phosphate dose held true over a tested range of 0·1 to 3 micrograms of the phosphate. As with acetyl-choline, the degree of antagonism was the same when the streptomycin was added to the bath only a few seconds before the histamine acid phosphate and when they were added together as a pre-mixed solution.

To assess more accurately the quantitative relationship between concentration of streptomycin and amount of histamine acid phosphate inhibited, streptomycin was dissolved in Tyrode's solution and set up in the alternative reservoir system. At a concentration of $1 \times 10^{-3}$ *M* streptomycin in Tyrode's solution, the contraction produced by histamine acid phosphate approximately equalled that produced by half the amount of the drug in the absence of streptomycin. Even when the gut was exposed to this concentration of streptomycin for as long as 15 min., there was no evidence of increased inhibition of response to successive doses of histamine acid phosphate.

The addition of streptomycin during the contraction caused by histamine acid phosphate, acetyl-choline or peptone produced immediate partial relaxation, and successive small additions of streptomycin resulted in a step-wise relaxation.

The sulphate, calcium chloride complex and hydrochloride salts of streptomycin of several different makes were tested with essentially the same results. Sterile aqueous solutions of streptomycin at concentrations of 50 mgm. and 100 mgm./ml. kept at 0–4° C. for periods up to a year showed no diminution of inhibitory action on gut response to the contractor substances tested.

Preliminary experiments on the chloralosed cat have shown no inhibition of the blood-pressure response to intravenous histamine acid phosphate or acetyl-choline by streptomycin administered intravenously in doses up to 30 mgm. per kilo of body-weight, either when the streptomycin was administered up to 15 min. before the depressor substance, or when they were administered simultaneously.

It is difficult to exclude the possibility that the results obtained using the gut preparations may be due, not to the streptomycin, but to an impurity.

If such an impurity were comparable in activity to some of the more recently discovered anti-histamine substances, a concentration of less than 1 part in a million in the streptomycin could produce these effects. However, it seems unlikely that an impurity active in very low concentrations would be present in such constant amounts in all the streptomycin preparations tested. Furthermore, it has been shown[4] that less highly purified preparations of streptomycin have a definite histamine-like action.

We are indebted to Dr. W. H. Hughes and Dr. H. C. Stewart for their advice and criticism, and to Dr. P. A. Nasmyth for his assistance with the cat experiments.

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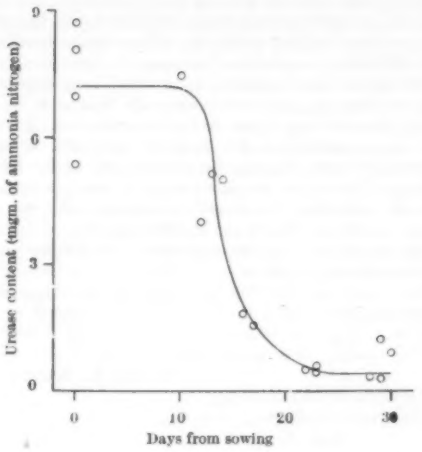
## Function of Urease in *Citrullus* Seeds

IT is customary to assume that an enzyme fulfils the function *in vivo* that it exhibits *in vitro*, however surprising the conclusions to which this leads; yet it is frequently overlooked that, were its true function unknown, hæmoglobin might similarly be credited only with its powers of acting as a peroxidase, or absorbing carbon monoxide, neither of which would form a useful basis for a study of the physiology of blood. The extremely high concentration of urease found in a number of seeds is an interesting example of this type of problem; it can, for example, be readily calculated from the results below that the cotyledons of the seed of *Citrullus* (the water-melon) contain sufficient urease to decompose more than their own weight of urea every hour. Moreover, the technique used has been such that this result is almost certainly too low. An extensive literature on the occurrence of urease exists, virtually all of it directed to the production of pure or concentrated urease preparations for kinetic studies or urea determinations; the function of the urease in the seed receives in general no more than a puzzled mention.

I suggest that the urease is present simply as a reserve protein, and that its urea-hydrolysing capacities are, so far as the seed is concerned, completely irrelevant. If this is true, some light might be expected to be thrown on the problem by investigating the fate of the urease when the seed germinates.

*Citrullus* seeds ('mixed') were sown in soil and the seedlings harvested individually at irregular intervals. No selection was carried out, and germination was distinctly erratic, the seedlings emerging between about the tenth and fifteenth days after sowing. It was ascertained by qualitative methods that all but a trace of the urease present was in the cotyledons, so further investigation was confined to these. The cotyledons of a given seedling were ground up in water and a known quantity of this extract digested




with 3 per cent urea in *M*/6 phosphate buffer at *p*H 7 for 15 min. at 30° C., the reaction being stopped with saturated potassium carbonate solution and the ammonia determined by aeration into *N*/100 sulphuric acid. The accompanying figure, in which each point represents in arbitrary units the total amount of urease in a single seedling, shows the results obtained. Despite the great variability, the general pattern is clear: on germination, there is a sharp fall in urease content to about one-fifteenth of the amount present in the seed. Since urease is not destroyed in the course of the reaction it promotes, this is incompatible with its enzymatic function; but it is exactly what would be expected if urease, in common with the other reserve material of the seed, were being drawn upon as a reserve protein during the early stages of germination.

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## Appearance of *Elminius modestus* Darwin in South Africa

GREAT attention has been directed recently to the occurrence of the barnacle *Elminius modestus* along the south coast of Britain, where it is supposed it has been carried on the hulls of ships from Australia[1]. Prior to 1945, this southern hemisphere barnacle had never been recorded in the northern hemisphere; but in that year Bishop[2] and Crisp and Chipperfield[3] noted it in great numbers at Chichester and Fambridge, Essex. Since then it has spread so rapidly along the south coast of Britain that it is now a potential enemy of the periwinkle and oyster industries[1,2].

Although *Elminius modestus* is reputedly a southern hemisphere species, it appears to be restricted to Australia and New Zealand[4], and up to the present had not been recorded in South Africa. Recently, however (July 1949), on experimental plates kept by Dr. N. A. H. Millard and myself in Cape Town Docks, a single individual appeared on a plate which had been submerged at a depth of 2 ft. for three months. This specimen measured 3 mm. carino-rostrally, and,

assuming the growth-rate is comparable to a growth of 6 mm. in forty days recorded by Bishop in England, this specimen would not be as old as three months.

If *Elminius modestus* becomes more prolific in South Africa and spreads, as it did along the south coast of Britain and even over to Holland[1] within three years of its first being recorded, it is likely that competition with *Balanus algicola* is more keen than with *Balanus balanoides* and other British species. The reason for this is that *B. algicola* appears, like *E. modestus*, to breed practically all the year round[6], and it is the most prolific species of barnacle in the Cape, settling to a density of 130 per sq. in. on experimental plates.

The incidence of *E. modestus* in the Cape Town Docks suggests that it has been introduced on the hull of a ship. If it becomes established, its spread will be noted with great interest.

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Aug. 3.

[1] Bassindale, R., *Proc. Bristol Nat. Soc.*, **27**, Pt. 4, 223 (1947).
[2] Bishop, M. W. H., *Nature*, **159**, 501 (1947).
[3] Crisp, D. J., and Chipperfield, P. N. J., *Nature*, **161**, 64 (1948).
[4] Darwin, C., "A Monograph of the Sub-Class Cirripedia", **2** (1854).
[5] Knight Jones, E. W., *Nature*, **161**, 201 (1948).
[6] Moore, Lucy B., *Trans. Proc. Roy. Soc., New Zealand*, No. 2, **73**, 315 (1943–44).

## A Species of *Stauromatonema* in Mysore

COLLECTIONS of algæ made in the Cauvery River, Mysore, included a species of *Stauromatonema*, a member of the Capsosiraceæ. The alga was associated with *Nostochopsis lobatus* (Wood) Geitler[1], on the submerged rocks and small pebbles. The colonies appear as small brownish-green incrustations usually distributed on rock surfaces that are exposed directly to water currents. This is in contrast to the conditions in which *Nostochopsis lobatus*[2] is found.

The thalli of *Stauromatonema* formed tough flat incrustations on the rock surface, so that it is very difficult to get good mounts showing all parts of the thallus. The thallus is composed of a basal prostrate system, having a cellular sheet (Fig. 2), formed by contorted filaments which show irregular cell divisions. From these, erect filaments which are parallel to one another and compactly grouped to form a concrescent cushion are produced. The filaments are simple or show lateral pseudodichotomous branching, the latter being upcurved and disposed in a parallel manner. The cells of the filament are rectangular, being broader than long, measuring 5–9 μ in diameter with a mean of 7 μ. The mucilaginous sheath is firm and persistent. The cells of the filament show intercellular connexions (Fig. 1). A few heterocysts have been noticed which are colourless, with refractive cell contents, and resemble those described by Frémy (Geitler)[1]. In several cases the planococci (Fig. 1), similar to those reported and illustrated by Frémy, have been observed.

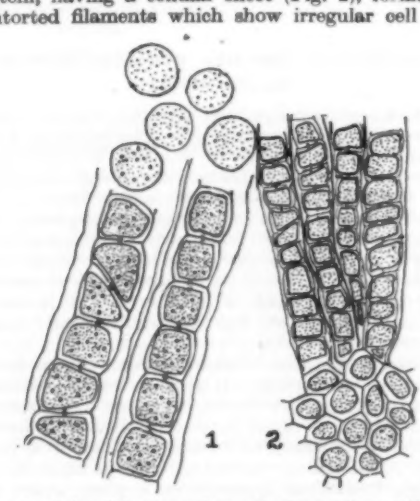



Fig. 1. Intercellular connexions and planococci. × 1,500
Fig. 2. Portion of the prostrate system and erect filaments. × 750

The present record of the alga in Mysore is of interest since the previous report of it has been only from tropical Africa by Frémy. The abundance of the alga in several places indicates that it may prove to be a very common alga of fast-flowing streams in Mysore. The alga under study resembles *Stauromatonema viride* described by Frémy (Geitler)[1] in several respects, and is tentatively referred to that species.

We wish to express our thanks to Dr. M. J. Thirumalachar for help in making field observations.

H. C. GOVINDU
K. M. SAFEEULLA

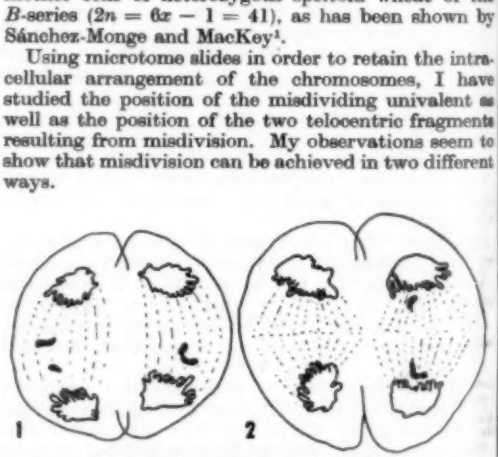
20 Fifth Main Road,
Malleswaram,
Bangalore.
July 14.

[1] Geitler, L., Cyanophyceæ, Rabenhorst's Kryptogamenflora von Deutschland, Osterreich und der Schweiz, 467 (1932).
[2] Govindu, H. C., Razi, B. A., and Safeeulla, K. M., *Curr. Sci.*, **18**, 258 (1949).

## Two Types of Misdivision of the Centromere

MISDIVISION of the daughter-univalents at second meiotic anatelophases occurs frequently in the pollen mother cells of heterozygous speltoid wheat of the *B*-series ($2n = 6x - 1 = 41$), as has been shown by Sánchez-Monge and MacKey[1].

Using microtome slides in order to retain the intracellular arrangement of the chromosomes, I have studied the position of the misdividing univalent as well as the position of the two telocentric fragments resulting from misdivision. My observations seem to show that misdivision can be achieved in two different ways.




In some cases the position of the telocentrics and their diverging proximal ends (Fig. 1) indicates that the misdivision is due to an attraction of the spindle poles acting in opposite directions on the two transversal components of the centromere or half-spindle spherules[2,3]. Thus this type of misdivision is a

consequence of an error, either of direction of attraction or of insertion of the chromosomal spindle fibres on the half-spindle spherules. This form of misdivision could be correctly called 'attraction-misdivision' or shortly '*a*-misdivision'.

In other cases, the stretched and converged proximal ends of the telocentrics (Fig. 2) suggest a pushing away of the two arms of the daughter-univalents, produced either by the so-called stem-body or by the forces assumed by Östergren to act within the spindle tactoid[4]. This pushing away of the chromosome arms produces at first the separation of their distal ends, afterwards the stretching and finally the misdivision of the centromere. This mechanism may act too late or not strongly enough, and then the misdivision is completed by the formation of the cell wall[5]. This second type of misdivision can be called 'push-misdivision' or '*p*-misdivision'.

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Zaragoza, Spain.
Aug. 19.

[1] Sánchez-Monge, E., and MacKey, J., *Hereditas*, **34**, 321 (1948).
[2] Östergren, G., *Botaniska Notiser*, 176 (1947).
[3] Lima-de-Faria, A., *Hereditas*, **35**, 77 (1949).
[4] Östergren, G., *Botaniska Notiser*, 467 (1945).
[5] Nishiyama, I., *Mem. Coll. Agric., Kyoto Imp. Univ.*, 32 (1934).

## A New Species of Root Eelworm Attacking Carrots

In the summer of 1944, cysts of a root eelworm were found on carrots growing on a smallholding at Chatteris in the Isle of Ely. Afterwards, infestations were noted on carrots in several other fields in the same area, some of which were alleged to have grown carrots for twenty years in succession. Where the infestation was heavy, the crop was poor and patchy. Plants lifted from the poor patches were stunted and carried an abundance of lateral roots; but this development of lateral roots was less marked than in sugar beet heavily attacked by the beet eelworm (*Heterodera schachtii*).

So far as I am aware, the only previous record in Great Britain of carrots being attacked by a cyst-forming species of *Heterodera* is that of Triffitt[1]. The species appears to be new and undescribed, and a summary of its more important features is given below.

Carrot root eelworm (*Heterodera carotæ*, n.sp.)

| | |
|---|---|
| *Cysts* | |
| Shape | Lemon |
| Size, length | Max. 0·68 mm.; min. 0·21 mm. |
| breadth | Max. 0·53 mm.; min. 0·15 mm. |
| Length/breadth | 2·3 to 1·35 |
| Regression coefficients | |
| Length/breadth | 0·6584 ± 0·057 |
| Breadth/length | 0·7084 ± 0·059 |
| Colour | White changing to brown on death of female. No intermediate yellow stage, as in potato root eelworm |
| Gelatinous egg sac | Present and large, in full-grown specimens equal in size to the cyst and containing many eggs |
| *Larva* | |
| Length | 454 $\mu$ |
| *Male cysts* | |
| Size on rupturing cortex | 0·33 mm. × 0·09 mm. approximately |
| *Males* | |
| Size, length | 1·19 mm. |
| breadth | 31·4 $\mu$ |
| Stylet | 28·8 $\mu$ |
| Copulatory spicule | Bi-dentate as in *H. schachtii* |
| *Host range* | Only cultivated and wild carrot attacked out of 106 plants tested, including the hosts of other common species of *Heterodera* |

*H. carotæ* falls into the group of *Heterodera* species in which the male has copulatory spicules with bi-dentate tips, as in *H. schachtii* and *H. cruciferæ*. On this character alone it can be distinguished from the other species. From *H. schachtii* it differs considerably in size and shape, and in the possession of a large egg sac into which many eggs are extruded. From *H. cruciferæ* it can be distinguished by its smaller size, by differences in its length–breadth relationships and in host-range. In addition, the larval length of *H. cruciferæ* is given as 418 $\mu$ by Franklin[2], whereas that of *H. carotæ* is 454 $\mu$.

An account of *H. carotæ* and of observations on other species of *Heterodera* is being prepared for publication elsewhere.

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Aug. 30.

[1] Triffitt, M. J., *J. Helminth.*, **13**, 3 (1935).
[2] Franklin, M. T., *J. Helminth.*, **21**, 2 and 3 (1945).

## Blinking and Sleep

As normal blinking is involuntary, it might be expected that blinking would proceed at its normal or at a somewhat reduced rate during sleep, as with breathing and the heart-beat. This is not so, however, though little seems to have been published on the subject, especially on the quantitative side. Whereas many of the muscles are relaxed during sleep, "the muscular tone of the muscles which keep the eyes closed is undoubtedly increased". Duke-Elder[1] states that the occurrence of bilateral blinking movements "may be used as a test for the simulation of sleep".

My interest in the subject has prompted me to utilize the relatively few opportunities open to a physicist to examine the problem on a number of children and on several adults. In all cases so far examined, it has been found that in sleep the eyelids are quiescent, and show no signs whatsoever of blinking movements.

During a recent long train journey, opportunity was afforded of examining the problem in its quantitative aspects, the subjects being a young man and his wife, both of whom fell asleep several times during the course of the journey. Their interblink periods were determined when awake (eyes open), when resting with closed eyes, and observations were continued for up to 15 min. after they had fallen asleep. In each case the conditions of the individual tests were clearly as nearly identical as was possible, and check determinations could be made; the subjects were quite unaware that they were under observation. The results are incorporated in the accompanying table. It did not prove practicable to obtain an accurate determination of the interblink period of the male resting with closed eyes, owing to the rapid onset of sleep in his case; but accuracy was possible with the female, who rested with closed eyes occasionally for a period greater than ten minutes.

| Condition of subject | Interblink period | |
|---|---|---|
| | Male | Female |
| Awake (eyes open) | 2·0 sec. | 1·6 sec. |
| Resting (eyes closed) | *c.* 1·8 sec. | 1·6 sec. |
| Asleep | ∞ | ∞ |

Interesting conclusions follow from these observations. The interblink periods of each subject when awake and when in the resting condition were sensibly identical, whereas in sleep bilateral lid movements ceased entirely. There was no indication in either case of any slowing down of the blink-rate with the approach of sleep; indeed, on one occasion the female subject ceased blinking immediately after three lid movements each separated in time by less than one second. It appears that the time taken for the transition from consciousness to unconsciousness under natural conditions is not more than one or two seconds. There was no clear indication that the degree of closure of the eyes during sleep was greater than when the eyes were closed voluntarily during resting periods.

ROBERT W. LAWSON

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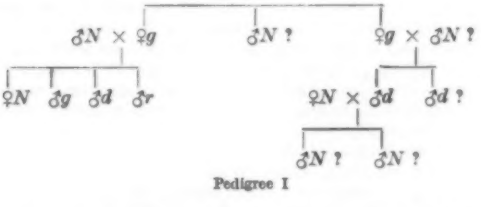
Sept. 1.

[1] "Text-Book of Ophthalmology", 1, 644 (Henry Kimpton, London, W.C.1, 1942).

## Three Pedigrees for Colour Blindness

THREE pedigrees have been found which are of interest in relation to the two-locus theory of the inheritance of red-green blindness formulated by Waaler[1] and Franceschetti[2], and summarized by Gates[3]. The present hypothesis suggests two series of alleles with near loci on the *X*-chromosome, *N*, *r*, *r′*, *p* and *N′*, *g*, *d′*, *d*, in which *N* and *N′* stand for the normal genes, *r* for red anomaly, *r′* for red anomaly with darkened red[4], *p* for protanopia, *g* for green anomaly, *d′* for deviant or anomalous deuteranopia[5], and *d* for ordinary deuteranopia. The orders of dominance are believed to be as shown above, *N* and *N′* being the most dominant. The two-locus theory is supported by the observation that certain women carrying genes from both series are of normal phenotype[1,2,6,7], and the discovery all over the world of fewer women defectives[8] than would be expected on the single-locus theory by the calculation given by Ford[9].

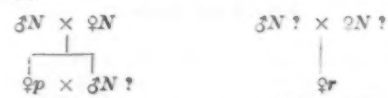


Pedigree I

In Pedigree I there are two green anomalous sisters whose brother (deceased) was believed to be normal. These sisters married men who were believed to have normal colour vision because they were employed on the railway. One, who was tested by me, was normal; the other (deceased) had not been suspected of any defect. The first sister had four children: a normal daughter, one deuteranope son, one green and one red anomalous, all tested by me. The other sister had two sons, one a deuteranope, exactly like his cousin in every detail of colour vision, married to a normal woman and having two sons believed normal but too young to test. The other (deceased) was believed to have been a deuteranope.

In order to explain this pedigree, we may assume that the two sisters were both double heterozygotes of genotype *rg*/*Nd*, and their brother *NN′*/—, using the system of notation suggested by Ford[9], in which the oblique line separates genes on different chromosomes. Their deuteranope sons would be *Nd*/—, while the green and red anomalous sons would be produced by crossing-over, the green anomalous being *Ng*/— and the red anomalous *rd*/—. The genotype of the red anomalous son is a conjecture based on the assumption that the gene which is more dominant in its own series would be more effective in this combination than the gene of lower dominance in the parallel series. Another conjecture would be that the genes *r* and *d* together would produce only that quality in the phenotype which they could share. The red anomalous colour match in the Rayleigh equation is a possible match for a deuteranope, whereas all other possible deuteranope matches would be impossible for red anomalous vision. The latter conjecture would apply only when the red end of the spectrum is not darkened in red anomalous vision, as in the present case.

The normal daughter might be of genotype *rg*/*NN′*, a double heterozygote in which the two defective genes in different loci have equal and opposite effects, and probably cancel each other out. De Vries has suggested that this combination is of normal phenotype[6].



Pedigree II[9] Pedigree III

Pedigrees II and III illustrate the possibility that a man of normal phenotype may have a colour-blind or anomalous daughter and a normal son. In Pedigree II we may assume that the father was of genotype *pd*/—, and of normal phenotype, which has been suggested for this combination when it occurs in a woman in the form *pd*/*NN′*. If the mother was a normal heterozygote of genotype *pN′*/*NN′*, the daughter would be *pN′*/*pd*, a protanope homozygote and a deuteranope heterozygote together. The son, if normal as believed, would be *NN′*/—, or, if not normal, then a protanope, *pN′*/—.

In Pedigree III the father, believed to be normal, might be of genotype *rg*/—, and of normal phenotype because these genes produce equal and opposite effects, while the mother could be the normal red anomalous heterozygote, *rN′*/*NN′*. The daughter would be *rN′*/*rg*, a red anomalous homozygote and green anomalous heterozygote at the same time, and be of red anomalous phenotype, as found.

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Aug. 26.

[1] Waaler, G. H. M., *Z. für. ind. Abs. und Ver.*, **45**, 279 (1927).
[2] Franceschetti, A., *Schweiz. Med. Wochensch.*, 58, **52**, 1273 (1928).
[3] Gates, R. R., "Human Genetics", chapter 6 (1946).
[4] Pickford, R. W., *J. Psychol.*, **27**, 153 (1949).
[5] de Vries, Hl., *Physica*, **14**, 367 (1948).
[6] de Vries, Hl., *Genetica*, **24**, 199 (1948).
[7] Gray, R. C., *Nature*, **153**, 657 (1944).
[8] Ford, E. B., "Genetics for Medical Students" (2nd edit., 1946).
[9] Pickford, R. W., *Nature*, **162**, 684 (1948).

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, January 16

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.30 p.m.—Prof. R. A. Morton: "Biochemistry of Carotenoids". (Further Lectures on January 23 and 30.)*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Canon Jules Detry: "Forbidden Tibet".

## Tuesday, January 17

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Sir Harold Tempany: "Some Agricultural Problems of the Colonial Empire".

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. M. G. Kendall: "The Statistical Approach" (Inaugural Lecture).*

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. D. K. C. MacDonald: "Fluctuations Noise and Recent Developments".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Dr. T. H. Morton: "Textile Applications of Synthetic Resins". (Members of the Textile Institute and the Society of Dyers and Colourists are invited.)

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, CAMBRIDGE RADIO GROUP (at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Mr. K. F. Sander: "The Application of Differential Analysers with Electrolytic Tanks for Tracing Electron Trajectories".

## Wednesday, January 18

INSTITUTE OF PHYSICS (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. E. W. Golding: "Windmills as Electrical Power Generators".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Prof. W. J. M. Mackenzie: "Unacknowledgeable Means".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—"The Piping, Storage and Transport of Liquefied Gases".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Annual General Meeting; at 6 p.m.—Dr. R. J. Ludford: "Chemically Induced Derangements of Cell Division" (Presidential Address).

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-EASTERN SECTION (at the Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. G. H. Hickling: "Activities and Equipment of an Industrial Electronic Laboratory".

INSTITUTION OF ELECTRICAL ENGINEERS (at the Central Hall, Westminster, London, S.W.1), at 6.30 p.m.—Dr. R. A. Smith: "Radar" (Faraday Lecture). (To be repeated at 6.30 p.m. at The Guildhall, Southampton, on Friday, January 20.)

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. J. Ward: "Photo Elasticity".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the LONDON SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY, at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6.30 p.m.—Mr. A. K. Soper: "The Physical Chemistry of the Gelatin-Water System".

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. D. G. Beech: "Graphs and Correlation". (To be repeated at 6.30 p.m. at the Chamber of Commerce, 95 New Street, Birmingham, on Wednesday, March 22.)

## Thursday, January 19

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Evolution of Arthropodan Locomotory Mechanisms" (to be opened by Dr. S. M. Manton, F.R.S., and Dr. C. F. A. Pantin, F.R.S.).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. D. Mekayn: "Integration of the Laminar Boundary Layer Equations".

SOCIETY OF ANTIQUARIES OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Miss K. M. Kenyon: "The Excavation of Sutton Walls Camp, Herefordshire".

ROYAL AERONAUTICAL SOCIETY (joint meeting with the ACOUSTICS GROUP of the PHYSICAL SOCIETY, at 4 Hamilton Place, London, W.1), at 5.30 p.m.—Short Lectures on "Acoustical Aspects of Recent Aerodynamic Research".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Prof. E. E. Turner, F.R.S.: "Modern Trends in Stereochemistry".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. A. J. Tyrrell: "The Performance and Stability of Permanent Magnets".

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Prof. C. A. Coulson: "Localised and Non-localised Bonds".

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7.15 p.m.—Prof. M. G. Evans, F.R.S.: "Studies on Electron-transfer Reactions" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. N. H. Swellengrebel (Amsterdam): "The Malaria Epidemic of 1943–46 in North Holland".

## Thursday, January 19—Friday, January 20

BRITISH INSTITUTE OF RADIOLOGY (joint meetings with the RADIOLOGICAL SECTION of the ROYAL SOCIETY OF MEDICINE, at 32 Welbeck Street, London, W.1), at 8.15 p.m. each day.

**Thursday, January 19**

"Use of Radioactive Isotopes—Some Diagnostic Techniques."

**Friday, January 20**

"The Therapeutic Uses of Radio-Isotopes."

## Friday, January 20

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2.15 p.m.—"The Locust Problem" (Dr. B. P. Uvarov: "Principles, Policy and Organization"; Dr. D. L. Gunn: "Research and Development").

CHEMICAL SOCIETY, BIRMINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. J. K. N. Jones: "The Separation and Determination of the Sugars and their Derivatives".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. James Tobin: "A Statistical Demand Function for Food in the U.S.A.".

MANCHESTER STATISTICAL SOCIETY (joint meeting of the STATISTICAL METHODS GROUP and the INDUSTRIAL GROUP, at the Albert Hall, Peter Street, Manchester), at 6 p.m.—Mr. G. F. Todd: "Statistical Aspects of Productivity Analysis".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP and the FINE CHEMICALS GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. A. C. Frazer: "Fine Chemicals and the Food Industry".

SOCIETY OF DYERS AND COLOURISTS, MANCHESTER SECTION (at the Gas Department Showrooms, Town Hall Extension, Manchester), at 6.30 p.m.—Mr. R. Thornton: "Some Critical Factors affecting the Development of Brentogens in Textile Printing".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Mr. J. A. Hall: "Temperature Measurement".

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Royal Academical Institution, Belfast), at 7.30 p.m.—Mr. J. McG. Jackson: "Chemical Education".

ROYAL SOCIETY OF MEDICINE, RADIOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Discussion on "The Therapeutic Uses of Radio-isotopes".

## Saturday, January 21

BIOCHEMICAL SOCIETY (at the British Postgraduate Medical School, Ducane Road, W.12), at 11 a.m.—Scientific Papers.

BRITISH MYCOLOGICAL SOCIETY (in the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3), at 11 a.m.—Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Dr. D. W. McElwain: "A Review of Psychology in Australia".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Richard Paget: "The Origin and Nature of Human Speech".*

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN CHEMISTRY at the County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (January 21).

LECTURER (Grade II) IN THE DEPARTMENT OF GEOLOGY, to teach applied geophysics—The Secretary, The University, Birmingham 3 (January 21).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with good honours degree or equivalent in physics) at the Atomic Energy Research Establishment, Harwell—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.320/49A (January 23).

LECTURER IN NEUROLOGY in the Department of Neurology, Manchester Royal Infirmary—The Registrar, The University, Manchester 13 (January 31).

PROFESSOR and a LECTURER IN MATHEMATICAL PHYSICS, a READER and a SENIOR LECTURER IN MATHEMATICS, a SENIOR LECTURER and two LECTURERS IN PHYSICS, a SENIOR LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY, a READER IN BOTANY, a SENIOR LECTURER IN PALÆONTOLOGY, a SENIOR LECTURER and a LECTURER IN PHYSIOLOGY, a SENIOR LECTURER IN ANATOMY, a SENIOR LECTURER IN PATHOLOGY, a SENIOR LECTURER IN MECHANICAL ENGINEERING (preferably in Fluid Mechanics), a SENIOR LECTURER IN CIVIL ENGINEERING, a SENIOR LECTURER IN MINING AND METALLURGY, a LECTURER IN ELECTRICAL ENGINEERING, a READER and a LECTURER IN PSYCHOLOGY, and a PROFESSOR OF PHILOSOPHY, at the University of Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

RESEARCH OFFICER, BUILDING RESEARCH SECTION, Melbourne (Ref. No. 2417), a RESEARCH OFFICER, PHYSICAL CHEMISTRY SECTION, Division of Industrial Chemistry, Fishermen's Bend (Ref. No. 2556), and a RESEARCH OFFICER, MINERALS UTILIZATION SECTION, Division of Industrial Chemistry, Melbourne (Ref. No. 2159), in the Commonwealth Scientific and Industrial Research Organization—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 4).

SENIOR SCIENTIFIC OFFICERS for theoretical work on problems in photoconductivity and theory of solids, SCIENTIFIC or SENIOR SCIENTIFIC OFFICER with post-graduate training in statistics for the planning and statistical evaluation of experimental work and trials, and SCIENTIFIC OFFICERS for (*a*) theoretical and experimental work on external ballistics and research on general theory of weapons, and (*b*) mathematical work on radar problems, at Ministry of Supply Research and Development Establishments in South England and South Midlands—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.326/49A (February 6).

SENIOR SCIENTIFIC OFFICER (Ref. No. A.179/49A) at the Ministry of Supply Tropical Testing Establishment, Nigeria, to lead group of physicists and engineers studying effects of tropical conditions on service materials and equipment, and an EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (Ref. No. G.253/49A) with at least Higher School Certificate qualifications in a biological subject or equivalent and some experience in fields of mycology and/or entomology—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 10).

PRINCIPAL OF THE L.C.C. NORWOOD TECHNICAL COLLEGE, Knight's Hill, West Norwood, London, S.E.27—The Education Officer (T.1), County Hall, London, S.E.1 (February 11).

READER, SENIOR LECTURER, or LECTURER, IN ANIMAL HUSBANDRY, at Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 15).

RESEARCH ASSISTANT IN DYEING—The Registrar, The University, Leeds 2 (February 15).

ANTHROPOLOGISTS (4, one experienced field-worker and three junior field-workers) at the East African Institute of Social Research, Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 18).

LECTURER IN ANATOMY at Makerere College, Uganda—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (February 18).

LECTURER IN MORAL PHILOSOPHY—The Secretary, The University, Aberdeen (February 18).

LECTURER IN AGRICULTURAL ZOOLOGY—The Secretary, The University, Aberdeen (February 28).

GRADUATES (men and women, of any University) for three Post-graduate Research Fellowships in special groups of subjects in the Faculties of Arts and Science—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 1).

SCHOLARSHIPS IN THE SCHOOL OF COSMIC PHYSICS: one in the Astronomical Section at Dunsink Observatory, Co. Dublin, and one in the Cosmic Ray Section, Merrion Square, Dublin—The Registrar, Dublin Institute for Advanced Studies, 64–65 Merrion Square, Dublin (March 1).

ASSISTANT LECTURER IN PHYSICS at the University College of the West Indies—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 1).

I.C.I. RESEARCH FELLOWSHIPS in Bacteriology, Biochemistry, Biomolecular Structure, Chemical Engineering, Chemistry, Chemistry of Leather Manufacture, Chemotherapy, Colour Chemistry and Dyeing, Engineering (Civil, Electrical or Mechanical), Fuel and Refractories, Geology (including Geochemistry), Metallurgy, Mining (Selective Flotation and Geophysical Surveying), Pharmacology, Physics, Physiology, Textile Industries (Protein Chemistry)—The Registrar, The University, Leeds 2 (April 30).

I.C.I. RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Engineering, Pharmacology, Physics or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

I.C.I. RESEARCH FELLOWSHIPS in Chemistry, Physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIP in Engineering, Inorganic Chemistry, Physics, or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

ASSISTANT MICRO-ANALYST (woman) in the Department of Chemistry—The Registrar, The University, Nottingham.

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Registrar, Municipal College, Portsmouth.

MECHANICAL ENGINEER (young, with good honours degree and preferably some experience of research methods) for experimental investigation of stresses in motor vehicle components—The Director, Motor Industry Research Association, Great West Road, Brentford, Middx.

METALLURGIST for work on surface metallurgy and metallurgy of coating processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICIST (graduate assistant, preferably with experience in electrophysiological and/or radiological techniques)—The Secretary, Nuffield Institute for Medical Research, 43 Woodstock Road, Oxford.

PHYSICIST (honours graduate with interest in properties of matter or mathematical physics) for fundamental research—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Lancs.

PHYSICIST (preferably graduate) for combustion and heating problems—The Assistant Secretary, British Coal Utilisation Research Association, Randalls Road, Leatherhead, Surrey.

SCIENTIFIC ASSISTANT for abstracting from foreign, especially Slavonic, literature on horticultural science—The Director, Commonwealth Bureau of Horticulture and Plantation Crops, East Malling, Kent.

ENGINEERS (Hydraulic) and ENGINEERS (Hydrology) in the Hydraulics Branch of the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/11 for Engineers (Hydraulic), and No. 27322/22 for Engineers (Hydrology).

PLANT CHEMISTS to undertake supervisory duties in connexion with the operation of a large chemical plant, PLANT ENGINEERS to undertake the maintenance of chemical and allied plant, and a PLANT INSTRUMENT ENGINEER (Springfields only) to be responsible to a Senior Engineer for the maintenance and development of instruments at the factory, in the Ministry of Supply Division of Atomic Energy (Production), at Springfields Factory near Preston, and Windscale Works, Sellafield, Cumberland—The Administration Branch, Division of Atomic Energy (Production), Risley, near Warrington, Lancs.

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# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

**Agricultural Research Institute of Northern Ireland.** Twenty-second Annual Report, 1948–49. Pp. 40. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1949.) [1110

**Department of Scientific and Industrial Research.** Report of the Chemistry Research Board, with the Report of the Director of the Chemical Research Laboratory for the Year 1948. Pp. vi+82+2 plates. (London: H.M. Stationery Office, 1949.) 2*s.* net. [111

**Colonial Office. Inter-University Council for Higher Education in the Colonies, Second Report, 1947–49.** (Cmd. 7801.) Pp. 18. (London: H.M. Stationery Office, 1949.) 6*d.* net. [111

**Ministry of Supply. Report of the Committee for Standardisation of Engineering Products.** Pp. 36. (London: H.M. Stationery Office, 1949.) 9*d.* net. [311

**Overseas Food Corporation. First Annual Report and Statement of Accounts for the Period ended March 31, 1949.** Pp. vi+158. (London: H.M. Stationery Office, 1949.) 3*s.* 6*d.* net. [411

**International Association for the Exchange of Students for Technical Experience. Second Annual Report.** Pp. 28. (London: J. Newby, General Secretary, Imperial College of Science and Technology, 1949.) [1011

**Manchester Public Libraries. 97th Annual Report of the Libraries Committee, 1948–1949.** Pp. 38+8 plates. (Manchester: Central Library, 1949.) [1011

**Occasional Notes of the Royal Astronomical Society. No. 13: Astronomy and Navigation. By D. H. Sadler.** Pp. 109–126. (London: Royal Astronomical Society, 1949.) 3*s.* 6*d.* [1311

## Other Countries

**United States Department of the Interior: Geological Survey. Bulletin 956: Geology and Ore Deposits of the Libby Quadrangle, Montana. By Russell Gibson; with Contributions on Glaciation, by W. C. Alden, and Physiography, by J. T. Pardee.** Pp. vii+131+11 plates. n.p. Bulletin 958: Bibliography of North American Geology, 1946 and 1947. By Emma Mertius Thom, Marjorie Hooker and Ruth Reece Dunaven. Pp. iii+658. 1.50 dollars. Bulletin 966-A: Geophysical Abstracts 136, January–March 1949 (Nos. 10737–11001). By V. L. Skitsky and S. T. Vesselowsky. Pp. iii+93. 25 cents. (Washington, D.C.: Government Printing Office, 1948–1949.) [111

**Department of Agriculture, Canada. Annual Report of the Forest Insect Survey, Forest Insect Investigations, 1948.** Pp. 124. (Ottawa: Department of Agriculture, 1949.) [1011

**Meddelande från Lunds Astronomiska Observatorium. Ser. 1, Nr. 167: A Composite Giant Star Model with Isothermal Core, Second Note. By Anders Reiz.** Pp. 7–10. Ser. 1, Nr. 168: Do Planetary Systems Exist? By Knut Lundmark. Pp. 20. Ser. 1, Nr. 169: The Structure of Degenerate Stellar Configurations near the Limiting Mass. By Anders Reiz. Pp. 6. Ser. 2, Nr. 126 (Historical Notes and Papers Nr. 22): Astronomical Records in the Russian Chronicles from 1000 to 1600 A.D. (as collected by D. O. Sviatsky). By A. N. Vyssotsky. Pp. 52. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1949.) [1011

**Institut Royal Météorologique de Belgique. Mémoires, Vol. 32: Ensoleillement et orientation en Belgique, 1. Par M. Nicolet.** Pp. 48. Mémoires, Vol. 33: Données complémentaires sur le climat du Congo Belge. 1, L'Humidité; 2, L'Évaporation; 3, La radiation, l'insolation et la nébulosité. Par A. Vandenplas. Pp. 73. Miscellanées, Fasc. 38: Sur la mesure des températures au voisinage du sol (données par les études de météorologie agricole). Par M. Nicolet. Pp. 8. (Bruxelles: Institut Royal Météorologique de Belgique, 1949.) [1011

**Bulletin of the American Museum of Natural History. Vol. 94, Art. 4: Embryonic Development of the Platyfish (*Platypoecilus*), the Swordtail (*Xiphophorus*), and their Hybrids. By William N. Tavolga.** Pp. 161–230. (New York: American Museum of Natural History, 1949.) 85 cents. [1011

**United States Department of Agriculture. Circular No. 813: Reducing Grasshopper Damage by Regrassing Weedy Roadsides and Fence Rows. By E. G. Davis.** Pp. 12. 10 cents. Circular No. 816: Grasshopper Egg-Pod Distribution in the Northern Great Plains and its relation to Egg-Survey Methods. By E. G. David and F. M. Wadley. Pp. 16. 5 cents. (Washington, D.C.: Government Printing Office, 1949.) [1411